FLIGHT
The AIRCRAFT ENGINEER & AIRSHIPS

First Aero Weekly in the World
Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice, and Progress of Aerial Locomotion and Transport
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DIARY OF FORTHCOMING EVENTS.

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in the following list:

1921

Jan. 10 ... **Meeting of the Bureau of the Federation Aeronautique Internationale in Paris**

Jan. 20 ... **Lecture, "The Cost of Air-Ton-Miles, compared with other Forms of Transport," by Lord Montagu of Beaulieu, before R.Ae.S.**

EDITORIAL COMMENT

Civil Aviation

SPEAKING in the House of Commons recently, Mr. Churchill said that the position of civil aviation is causing real anxiety to the Government. He further went on to say that he hoped it would be possible next year to give assistance to it in a new form. It was a question, he added, of tiding over the period until civil aviation comes into its own.

We are duly grateful for the reiterated promise of assistance, even though it be for the future when help is so urgently needed in the present. We completely realise the difficulties which beset the Government at the moment, and that it is not too easy to put into operation off-hand a scheme of subsidies to keep existing services alive or to encourage new ones to start. The inelasticity of the annual Estimates precludes the use of money saved under one vote for the purposes of another. Nevertheless, under all the circumstances we do not agree that nothing can be done for the time being. It is pretty certain, however, that we must rest content with the promises that are being given and with the knowledge that the future of civil aviation is really a matter of concern to the Government. More especially are we glad to gain the latter knowledge, since in view of the apathetic attitude which has been taken up in the past, we had come round to the belief that the Government had ceased to be concerned.

We could wish that the Air Minister had been able to be more precise in his statement, and could have indicated the probable form in which the promised assistance is to be given. For example, such assistance as has been given during the past year has been confined, according to the Reports of the Controller-General of Civil Aviation, to the creation of ground organisation on existing and proposed air routes. This has been found to be of very little avail so far as encouragement is concerned, since there has been no services to take advantage of the facilities thus created. It would be well to know how Government policy in the matter of encouragement is likely to shape, in order that those most nearly concerned may have an opportunity of examining the intentions and of making their plans accordingly. We suggest to Mr. Churchill that he might take an early opportunity of outlining that policy as nearly as he can. We quite realise that it may not be possible for him to say precisely what is to be done, but a general statement would be welcomed, and would be of the very greatest assistance in existing circumstances.

* * *

The Royal Air Force

For some reason or other the continued existence of the Air Force as a separate Service seems to give annoyance in some quarters. Hardly a week passes but questions are asked in Parliament regarding the policy of the Government in the matter, though it might have been thought that the Government's repeated enunciations of its policy would have carried assurance long ago. Last week the Prime Minister had once more to emphatically state that the maintenance of the separate Air Force was the considered

policy of the Government, and that the reasons for that policy were not properly to be discussed in an answer to a question. The whole subject, he said, could be fully debated when the Air Estimates come on for discussion next year. We should have thought that the experience of the last year of the War had entirely justified the existence of the R.A.F., and that there could no longer be any question of reverting to the bad old scheme of two Services, each fighting against the other in its own interests, which was as wildly extravagant in cost and, of greatest importance of all, wanting in efficiency in the result. It is evident, however, that the influences which are at work both at the Admiralty and the War Office to get back to the old state of things are still very active and will require a good deal of watching in the future, lest they should perchance get their own way by surprise.

Following the statement of the Premier, General Seely asked, if it was the policy of the Government to maintain a separate Air Service, why it does not have a separate Minister and so give the Navy a chance of getting the air service it needs? Now, without presuming to possess inside knowledge of whether the Board of Admiralty is satisfied or not that its requirements are being fulfilled by the Air Ministry, we quite appreciate that one of the great weaknesses of placing the control of both Army and Air Service under a single Minister is that allegations and innuendoes of this kind must inevitably result. And, whatever may be the real facts of the case, it will require more than a mere denial, such as was given by Mr. Lloyd George to the suggestion made by Gen. Seely, to convince the man in the street that the War Office does not get the cake while the Navy goes hungry. It is perfectly obvious, he argues, that a Minister who is at once Secretary for War and for Air will look after his own Department first and let the other take what is left. We do not say this is the case here, but the inference is a perfectly logical one. We will go farther and say that where a Minister of less powerful personality than Mr. Churchill might be concerned, the position would be highly dangerous and would lead to the exact results indicated. We trust sincerely that when the Air Estimates come before Parliament next year another strenuous endeavour will be made to get the anomaly redressed and a separate Air Minister appointed.

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The Big Ship Controversy

The two sides representing the Submarine and Aircraft *versus* the Big Battleship are continuing their controversy until the lay mind is almost completely bewildered by the mass of argument and counter-argument adduced by each to prove that the other is hopelessly wrong both in premise and in fact. For example, the advocates of the big ship point triumphantly to the Battle of Jutland, in which the value of aircraft for reconnaissance was admittedly very badly discounted. What, they want to know, is the use of depending even partially on an arm which showed itself deficient in its primary quality of gathering and transmitting information at the very time when that information was most required? There are several answers to the question. In the first place, the only German aircraft of which there is any record in connection with the battle were the seven Naval Zeppelins belonging to the enemy and which completely failed to locate the Grand Fleet at any time during the day. The principal cause of their failure seems to be that the strategic intelligence of the German commander-in-chief was at fault, in that he did not know the Grand Fleet was at sea at all and hence his Zeppelins were sent on another mission entirely. Had von Scheer known that the British fleet was actually at sea and advancing to meet him, there is very little doubt that his aircraft would have obtained touch quite early in the day. But as he neither expected nor desired to meet the British, it seems natural that he should not have employed aerial reconnaissance to locate an enemy which he supposed and hoped was not within hundreds of miles. That being so, it is certainly not the case that aircraft failed through any default of themselves as aircraft to influence the course of the battle. As a matter of fact, as for all practical purposes aircraft on the British side were non-existent, the truth is that there are no lessons at all, either for or against aircraft in naval war, to be deduced from Jutland, and it is merely confusing the issues to attempt to find them.

Nor is it at all safe to predicate that there are any lessons of the employment of aircraft in the sea affair which we can take as a real basis upon which to found policy, except those which were learned from the employment of airships and seaplanes against the submarine. These, it must be confessed, do not carry us very far on the way to a decision upon the vital questions at issue.

As a matter of fact, it would seem that all the evidence accruing from war experience and all the theories evolved from that and from the known possibilities of the immediate future must be thoroughly sifted and examined by expert opinion before any conclusions can be reached. The question of the rôle of aircraft in naval war is one that requires imagination to visualise—such imagination as led Lord Fisher to the reasoned opinion that with aircraft lies the whole future of war. The question bristles with difficulties. To attempt to mould policy on the past is to stultify the future. To attempt to see too far may land us in vital errors. For ourselves, we realise that this is not a question upon which the layman can express any definite opinions, but at least he is entitled to ask that the matter should not be decided upon opinion pure and simple. The issues can only be disentangled by the most meticulous enquiry, bearing in mind that upon the decisions may hang the whole future of the British Empire.

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Protection for the United States Industry

An American Court has just granted an injunction, restraining the Aircraft Disposal Co. and Messrs. Handley Page from importing into the United States 2,365 aeroplanes and 34,000 engines. The proceedings were brought by the Wright Aeronautical Co., holders of the original Wright patent, which declares that by taking the action it has it has performed a duty to the entire American aviation industry. American manufacturers, the Company explains, do not want to stifle fair competition, but they do not want the American market flooded with aeroplanes and engines, parts of which are obsolete and of war-time design and production.

The Wright Co. and the American industry at large are possibly within their legal rights in seeking protection at the hands of the Courts, and the defendant British concerns, if the decision is upheld, will no doubt view the decision with what grace they can and handle the new situation with their

The Camera and the 'Plane

Another view of Ghent as seen by the passengers on the Handley Page service between Cricklewood and Brussels.

characteristic energy. We cannot help, however, expressing the opinion that the action taken in the matter seems to be a very poor return for what was done during the War for the American industry by the very British designers and constructors whose productions they are now so anxious to keep out of their market. It is perfectly true to say that the American industry did not produce a machine or an engine fit for war purposes until our own designers gave the Americans the benefit of their knowledge and experience. British firms and designers like Handley Page and de Havilland, to mention only two, unreservedly placed at the disposal of American builders all their latest designs, and sent experts over to the States to explain and assist in producing machines which would fly under war conditions. What the results were we know. However, there is no need to pursue the matter. There is a moral attached for all to read.

The Universities and Aviation

In a recent issue of the *Birmingham Post* there appeared a very interesting interview, on the subject of the Universities and aviation, with Professor Lea, Professor of Civil Engineering at the Birmingham University. He pointed out that, after all, aeronautical engineering can only be based upon those fundamental principles which are common to all branches of engineering. The fundamental courses provided in the Universities give this basic instruction, but even the many subjects which are included do not encompass the whole problem. There is, he said, one particular section of the subject which cannot be dealt with in an adequate manner. This relates to the determination of the external forces acting upon aeroplanes and the particular shapes which must be given to wings and bodies so as to obtain maximum lift at any particular speed, the greatest degree of suitability, and at the same time the minimum resistance to friction and other aerodynamic losses. In this country the only places where such experiments could be carried out are the National Physical Laboratory, the R.A.F. establishment at Farnborough, and in certain of the large aircraft factories in which wind tunnels had been installed during the War. No University, said the professor, can take up this part of the subject without installing very expensive plant and setting apart special members of the staff to carry out essential research.

The whole matter seems to be one of endowment. Agreed that none of the Universities, with the exception possibly of Oxford and Cambridge, which are not so closely interested in scientific research of the kind as the younger and more technical foundations, can afford the expense. Nor can we expect that the State should come forward to find the necessary funds. One way and another, the question seems hedged about with difficulties. If there were in existence a great and flourishing aircraft industry, we should say without hesitation that it was the duty of that industry, from motives of self-interest alone apart from other considerations, to find the money for the research work which still remains, and will always remain, to be done. But the industry at the moment is neither great nor flourishing, and the present prospects of equipping the Universities are not encouraging. It would really seem to be a matter for private munificence—another Sir Basil Zaharoff is needed to step into the breach. If this country is to maintain its position in aeronautics, all the research work possible must be carried out, and the more experiment and research is multiplied over a number of centres the better it will be for the future of the industry. But how is it to be done?

THE LONDON-CONTINENTAL SERVICES

THE London-Continental Services during last week—December 19–25—were somewhat curtailed, owing, no doubt, mainly to the Christmas holidays; bad weather, however, was the cause of interrupting several trips on the various routes. On the Croydon-Paris route a Breguet (Messageries Aériennes) carrying two passengers, goods and mail, made a 2 h. 20 min. trip on the 22nd, but on the return trip the following day, with goods and mail, landed at St. Inglevert. Messrs. Instone's Vickers-Vimy made one trip to Paris with four passengers and goods, and returned to Croydon with two passengers and goods. Two Salmson machines, with goods, left Croydon for Paris, but both landed at St. Inglevert. On the Paris-Croydon route a Breguet (goods) and a Spad (goods and mail) both made successful trips, but three other Breguets, with goods, were forced to return to Paris, owing to fog, on the 21st.

Only two machines, Airco 4 and a Handley Page (both of Handley Page Transport), left Cricklewood for Paris, but both failed to reach their destination. The Airco 4, with goods, landed at St. Inglevert, and the Handley Page, with one passenger and goods, landed at Abbeville. No flights were made between Paris-Cricklewood.

Airco 4 "O-BABI" made a fast trip (1 hr. 50 mins.) with goods and mail from Croydon to Brussels on the 22nd, this being the only flight made on the Brussels service. A Sopwith "Dove" "G-EAFI," left Croydon for Stockholm, *via* Lympne and Amsterdam, on the 22nd, for the Norwegian Aviation Co.

An Air Board for South Africa

The South African Government has now appointed an Air Board to deal with aerial legislation, the development of aeronautics in South Africa, and with proposals for the establishment of mail and passenger services. The board is constituted as follows:—Sir Wm. Hoy (Chairman), Sir Robert Kotze, Sir Roland Bourne, Messrs. H. W. Twycross (Postmaster-General), A. D. Lewis (Director of Irrigation), G. O. Smith (Commissioner of Customs), with Mr. A. C. McColm acting as Secretary.

French Aircraft for Roumania

THE negotiations which have been taking place between representatives of the French and Roumanian Ministries of War have resulted, judging by news received in Paris from Bucharest, in an agreement, according to which France will deliver to Roumania aeroplanes and an important quantity of aviation material. Roumania, for her part will permit a large amount of petroleum and petrol to be exported to France.

German Air Minister Resigns

FOR some time opposition has been steadily growing in German aeronautical circles against the Under-Secretary of State for Aeronautics, Herr Euler, and it has ended in his resignation. It is probable that the Under-Secretaryship will be done away with, and the next official appointed be termed a Ministerial Director.

An Aerodrome for Frankfort

FRANKFORT-ON-MAIN has decided not to be left behind in the matter of air terminus facilities. The municipal authorities have decided to set aside a sum of 100,000 marks towards the cost of installing an aerodrome.

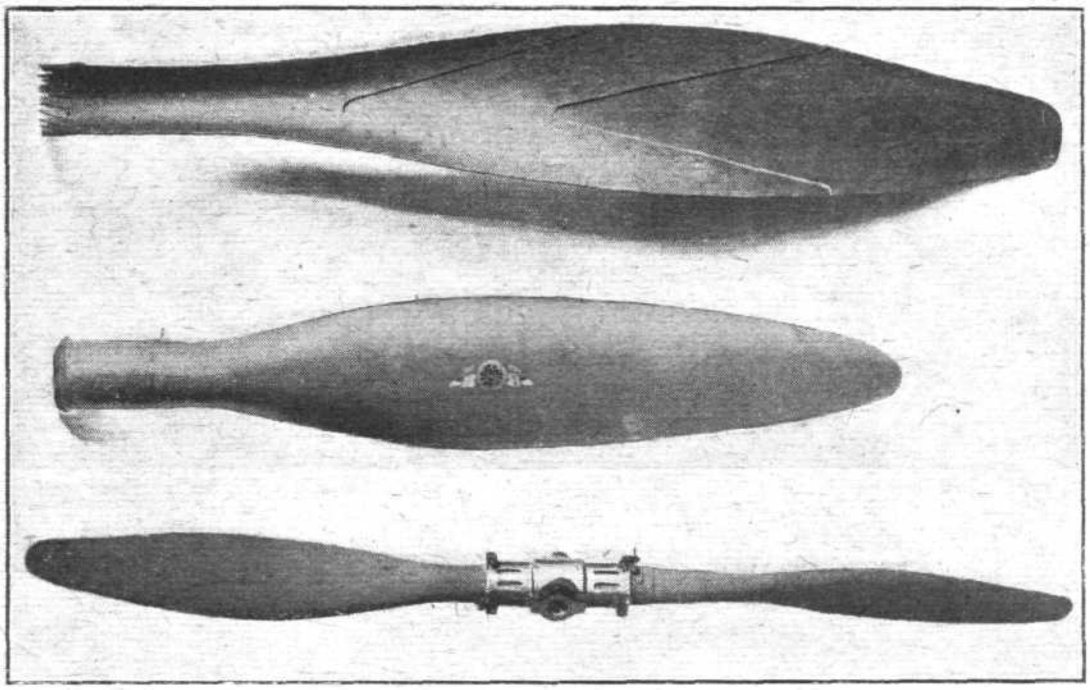
Americans also Want Schutte-Lanz Works

WORD comes from Berlin that American interests are not only seeking to obtain concessions from the Zeppelin works, but that they have also approached the Schutte-Lanz interests. This concern is believed to have built twenty-two rigid dirigibles, nine in the Rheinau works, one at Sandhofen, one at Darmstadt, eight at Leipzig, and three at Zeesen.

ALL-METAL AIRSCREWS

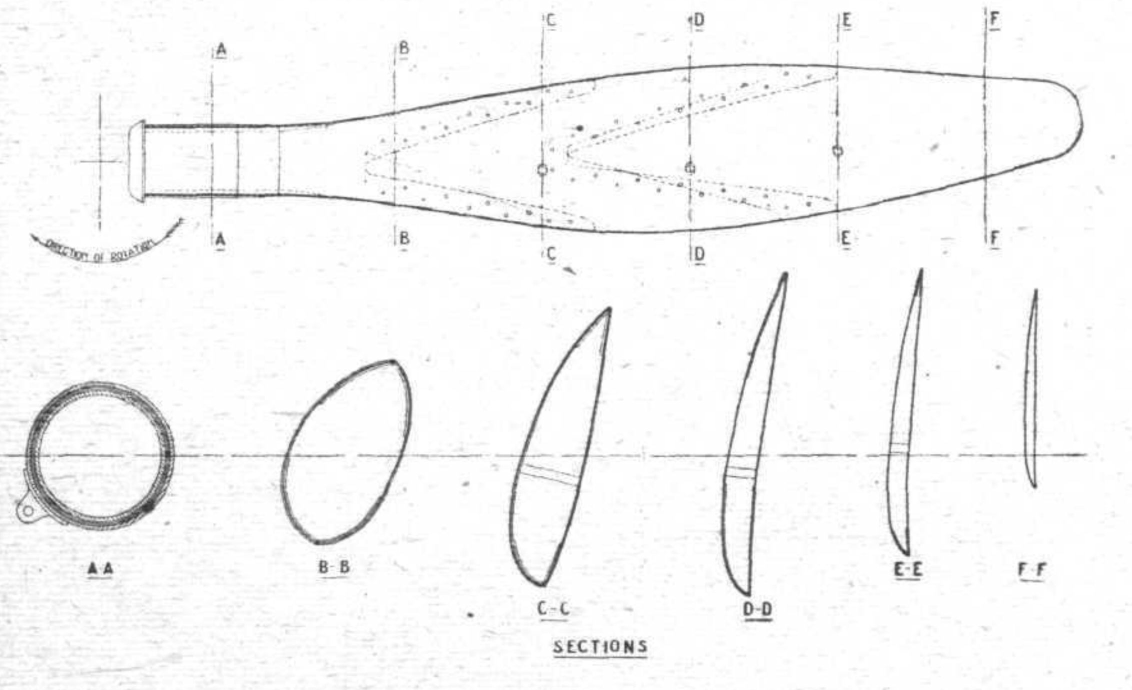
The Leitner-Watts Solution

WHILE there is certainly quite as great a practical need for all-metal airscrews as there is for all-metal aircraft, it is probably true to say that, although a great deal of research and experimental work has been done on metal construction of aircraft, far less energy has been devoted to the solution



A Leitner-Watts Propeller: The upper photograph shows the inside of a blade. Note the serrated edges at the root, which are tucked in between two sleeves, and thus hold the blade against centrifugal stresses. The photograph in the centre shows a finished blade, and the lower illustration shows the finished two-bladed screw.

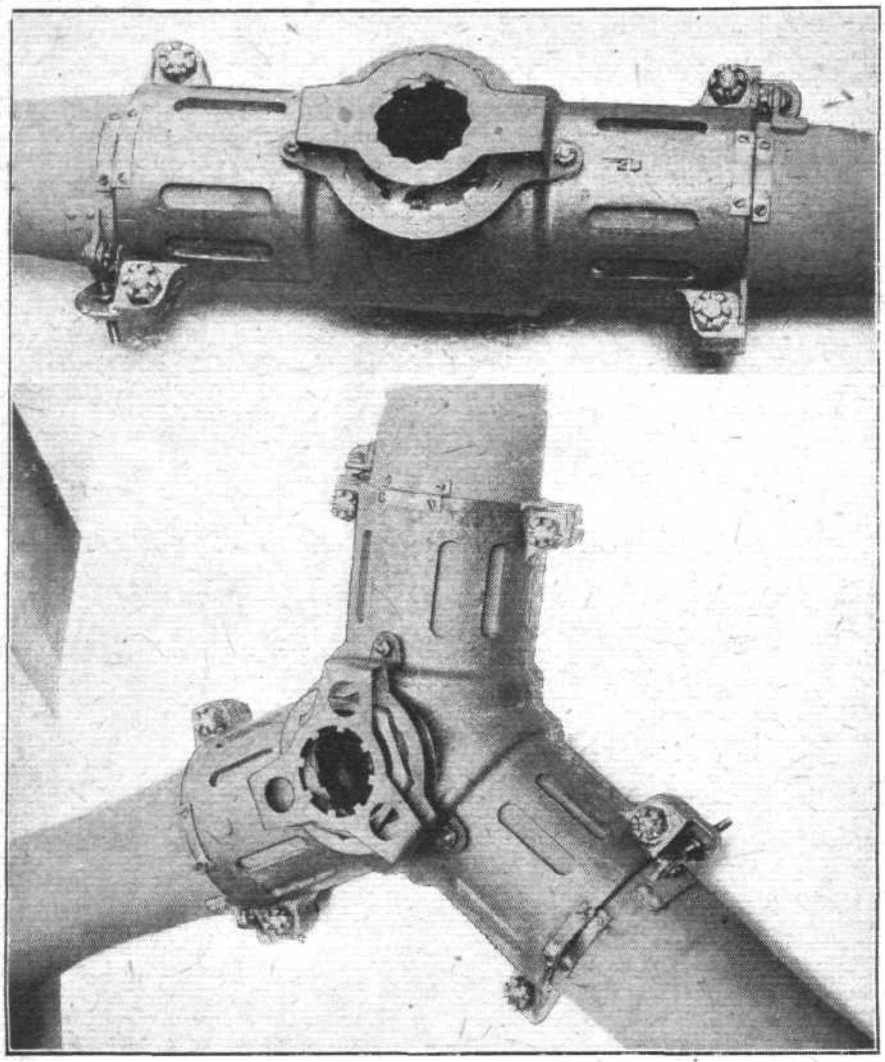
of problems relating to the production of metal airscrews. If, in spite of this, the metal airscrew has reached as great a degree of development as has the metal aeroplane, this is due not so much to the application of a number of firms to the problem as to the energetic development by a comparatively few firms. Among these must be counted in the front



General arrangement and sections of a Leitner-Watts metal airscrew blade.

rank the Metal Airscrew Company, whose offices are situated at Regent House, Kingsway, W.C.2.

It is now a good many years since Mr. Leitner set himself the task of producing a really satisfactory solution of the all-metal airscrew problem. The structural difficulties were quite serious enough, and in order to avoid adding to them by aero-dynamic considerations Dr. H. C. Watts was entrusted with the purely aerodynamic side of the design. The result of this collaboration is the present-day Leitner-Watts all-metal airscrew. Of the difficulties encountered there is no need to speak here. It will be realised by all who understand the subject that they must have been, and were, many and great. In the main the obstacles have now, however, been surmounted, and the all-metal airscrew is a *fait accompli*, although it can scarcely be claimed, nor do we think the designers make any such claim, to be perfect. It is, however, quite a practical proposition, and airscrews made by the Metal Airscrew Co., Ltd., have been thoroughly tested, in a tensile testing machine, by "spinning" at Farnborough, and last, but not least, in actual use on a Bristol seaplane. It may be stated that, broadly speaking, all but one of the



THE LEITNER-WATTS PROPELLER: The hub of a two-bladed, and below the hub of a three-bladed, propeller.

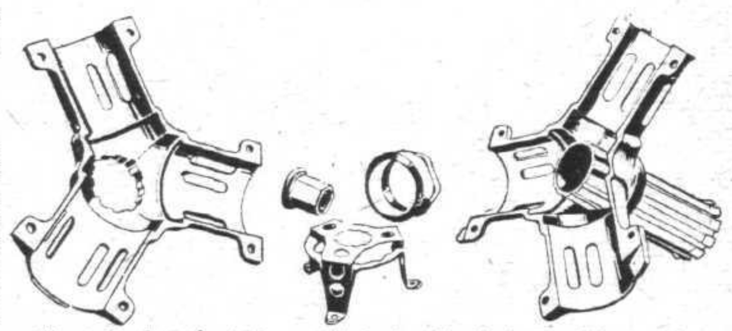
General Features

Briefly speaking, what the designers of the Leitner-Watts metal airscrews have done is as follows: Dr. Watts, who is, of course, one of our very front rank airscrew experts, has designated what may be termed a series of good all-round blades. Mr. Leitner and his staff, on the other hand, have translated these designs into metal construction, and have designed for them metal hubs into which fit two, three or four of these blades. In this way, out of a relatively small number of standardised parts, one can make up a large variety of screws to suit different conditions.

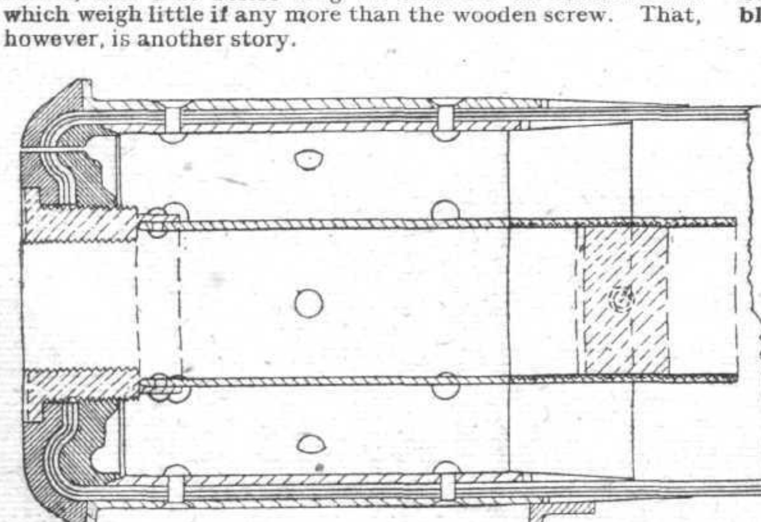
Blade Construction

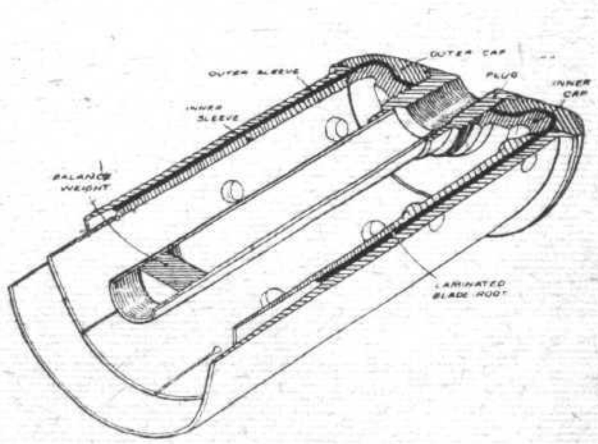
To deal with the propeller blades first. There are, of course, an almost infinite number of ways in which the construction of metal blades can be carried out. A series of experiments extending over several years have led to the adoption of the construction shown in the accompanying illustrations. Each blade is made up in the form of a shell of sheet steel, and the necessary taper in thickness is obtained by using laminated construction. There are in all three laminations, one at the top, two about half-way between tip and boss, and three at the root. The shape of the laminations will be seen from the illustrations. The outer shell runs right through, the second or middle lamination is forked at its outer end and extends inwards to the hub, the third and inner lamination extending from the hub and about halfway along the middle one. The three laminations are at present riveted together, but later on it is intended to employ electric spot welding instead of the rivets. This laminated construction has two advantages: it provides a means of proportioning, approximately, the blade strength to the stresses at any point, and it prevents vibrations being set

problems of the metal airscrew have been solved. This one is that of weight. In their present form these screws are certainly very considerably heavier than the corresponding wooden screws, but this is a drawback which the designers are confident of being able to remedy. From some recent designs which we have been permitted to examine, but about which nothing may be said at the moment, we incline to think that the question of weight is in a fair way to become solved, and that before long we shall see all-metal screws which weigh little if any more than the wooden screw. That, however, is another story.



Sketch showing the split hub of a Leitner-Watts three-bladed propeller. Note the splined bush which transmits the drive to the hub.





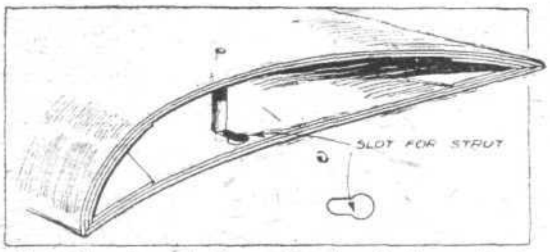
THE LEITNER-WATTS AIRSCREW: Sectional view of the root of a blade, showing inner and outer sleeves, caps, plug, etc., and on right sketch of a sectioned blade root of a Leitner-Watts propeller. Note the tube carrying the balance weight.

up, as each lamination has its own particular period which does not tally with that of the other two.

The two halves of each blade are attached to one another, at the edges only, by welding, but in order to stiffen the shell thus formed small struts are placed between the two faces at intervals. The manner of getting these struts into place is rather ingenious, and is illustrated in one of our sketches. The struts are shouldered at both ends, and the hole in one face of the blade is just the right size to take the thin portion of the strut. In the other face of the blade is cut a hole large enough to accommodate the thick portion of the strut. From this hole runs a slot of a width corresponding to the shouldered portion of the strut. To place in position, the strut is inserted through the large hole, its other end being pushed into the small hole on the opposite face, and the shouldered portion is slid into the slot. The strut is then secured in position by soldering washers over the two strut ends. Originally these washers were welded on, but the joint so made was not as neat as might be desired, and now soldering is employed, this having been found strong enough for the purpose.

The Very Substantial Blade Root

The root of the blades is so constructed that it is impossible, under stresses arising in ordinary use, for the blade to be



Sketch showing method of inserting small struts between front and rear faces of the propeller.

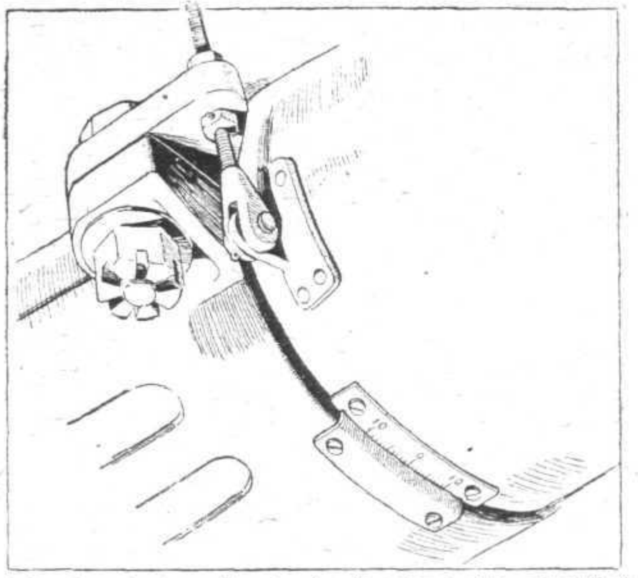
torn out of the central hub. The section and sketch of a sectioned blade root published herewith should make the details of the construction clear. The inner end of the blade is finished with serrated edges, as shown in the photograph of a half-blade. An inner sleeve is pushed into the hollow blade root, and on the inner end of this sleeve is placed a steel cap, the serrations of the blade projecting beyond this cap. The serrations are then bent over the rounded top of the inner cap, and the outer sleeve and cap placed in position, being locked in place by the central plug. Rivets passing through blade and sleeves further prevent the blade from pulling out, although the bent-over serrations probably relieve the rivets of practically all the shear stress. In addition to these precautions the sleeves are tinned before being placed in position, as are also the serrations, the whole being heated and soldered afterwards. In order to ensure free air circulation, and also to prevent excessive pressures when the machine rises to a great height, there are vent-holes both in the tip and root of the propeller blades.

Balance

In spite of every precaution in making up the blades, it is, of course, impossible to get them all of exactly the same weight or distribution of weight. In order to ensure perfect balance in running, small balance weights are used, which can also be seen on the sectional drawings. These weights are carried on short lengths of tube secured to the inner end of the central plug in the blade root. They are tinned before insertion in the tube, and when the right position for them has been found they are soldered and pinned in place. This balancing up is carefully done at the works, and if a user requires a single new blade he is ensured that the replacement will be correctly balanced when he gets it, and he therefore need not trouble about the balance of the new blade being right.

The Hub

The hub which holds the blade together is, in the earlier models, a split phosphor-bronze casting, shaped so as to house between its two halves, and gripping it tightly, the blade root. In addition to the friction the blade is held in position as regards centrifugal stresses by the shoulder on the blade root bearing against the recess of the boss. The latter is held to the engine-shaft *via* a splined bush, shown in the sketch of the hub for a three-bladed screw. This splined bush is standard as regards outside shape and dimensions, fitting all the different types of screws, but internally it is



Sketch showing method of adjusting the pitch of a Leitner-Watts metal airscrew.

finished to fit any particular engine. The method of locking it in place is shown in the sketch, and also in the photograph of the three-blade hub. In the latest type the hub is a steel drop forging, which makes a rather neater job.

Adjustment of Pitch

The Leitner-Watts metal airscrews have adjustable, although not as yet variable, pitch. That is to say, the pitch angle of the blades can be altered over a wide range—10 degrees each way—thus making a propeller suitable for a number of different conditions by setting the pitch according to requirements. For the purpose of adjusting the pitch vernier scales are placed on the blades and boss, the adjustment being made by means of a simple eyebolt as shown in our sketch. In this way very fine adjustment can be obtained, the vernier giving the angle and the turning of the locknuts on the eyebolt making the adjustment. It will, of course, be understood that before adjusting the angle of the blade the large bolts securing the two halves of the split hub are slackened, thus allowing the blade to rotate freely in the hub.

It has already been mentioned that the blades are standardised, so that the same blade can be used in a two, three or four bladed screw. This fact makes for economy of production and for satisfactory balance in the case of fitting a new blade. There is now, apparently, only one obstacle to be overcome, that of weight, but this also is being tackled with good prospects of success. In conclusion we would express the hope that the Metal Propeller Co., Ltd., will, having brought the *adjustable* pitch airscrew to such a considerable stage of development, devote their attentions also to the problems of the *variable* pitch propeller, which would seem to be the logical development. We fully realise the difficulties, but hope and think that they will be overcome.

The London–Birmingham Service

OWING to the continued bad weather, the opening of the experimental air service from London to Birmingham had to be postponed until December 22, when the conditions were considered entirely favourable. The first aeroplane to fly in connection with the new service left the Cricklewood Aerodrome, with freight, at 12.45 p.m. and arrived at Castle Bromwich Aerodrome at 2.30 p.m. In order to commemorate the first flight, the pilot, Lieut. R. H. McIntosh, presented a pilot's watch to the Lord Mayor of Birmingham, Alderman W. A. Cadbury.

Speed Tests with the Verville-Packard

WHILE speed tests carried out at Mineola recently with the Verville-Packard machine, which was entered as one of the representatives in the Gordon-Bennett race, failed to come up to expectations some interesting data was obtained. The best speed in six tests was 186 miles an hour, but it was found that while the 600 h.p. engine would run at 1,950 r.p.m. on the ground it would not exceed 1,750 r.p.m. in the air. Col. J. G. Vincent, the designer of the engine, attributes this to a vacuum being formed at the back of the carburettor, and wind tunnel tests are to be carried out.

AIR MINISTRY NOTICES

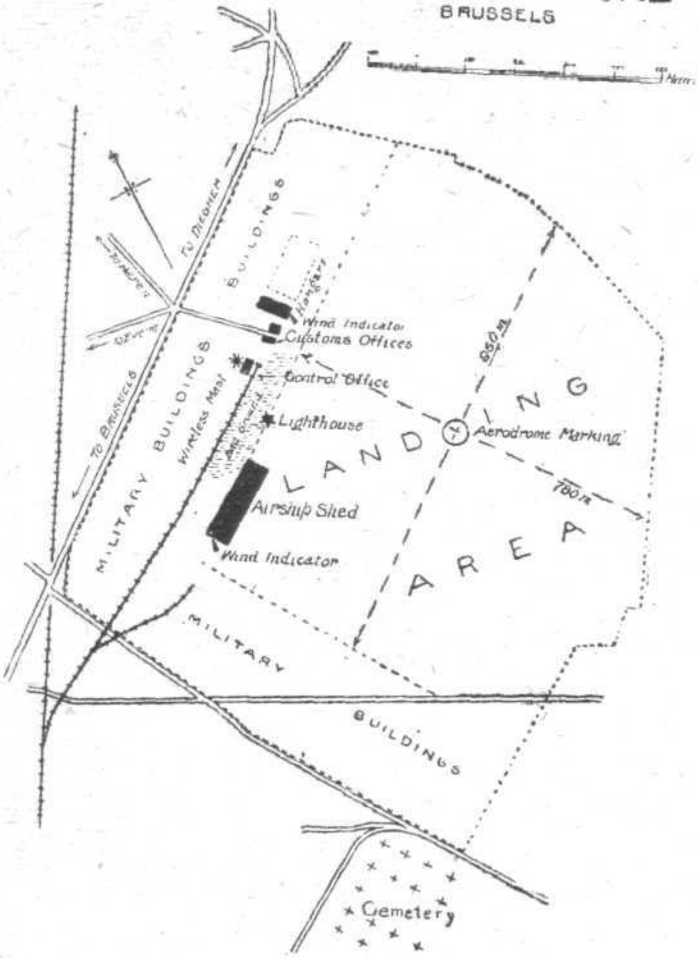
(139) Belgium: Customs Examination; Aerodromes (355041/20—368608/20)

1. THE attention of pilots is drawn to the fact that Article 19 of the Belgian Air Navigation Regulations (Belgian Royal Decree 6303/1919) contains the following clause—

Any aircraft coming from abroad or going abroad must land at or depart from a Customs aerodrome.

HAREN AERODROME

BRUSSELS



The *only* Customs aerodrome in Belgium at present is Haren (formerly Haren-Evere), at which *all* aeroplanes arriving in or departing from Belgium must undergo Customs examination and clearance.

2. The following information regarding Haren aerodrome has been received from the Belgian Government—

HAREN.—Military and Civil Aerodrome.

Position.—Latitude 50° 53′ 0″ N., Longitude 4° 25′ 0″ E. Situated 6 km. N.E. of the centre of Brussels, just east of Evere.

Maximum dimensions for landing.—950 × 780 metres.

Wind Indicators and Day Markings.—One wind sleeve above the wooden hangar and one above the military airship shed. A white circle is marked on the aerodrome.

Night Landing Arrangements.—An aerial lighthouse giving intermittent flashes, forming the letter "S" of the Morse code, is in operation from sunset to one hour after sunset, or whenever a machine is expected, and also during foggy weather. Petrol flares are also lit when a machine is expected. The flares are placed in the form of an isosceles triangle. Machines should land over the base of the triangle toward the apex.

Hangars, Supplies and Repairs.—Hangars, petrol, oil, water and good facilities for repairs are available.

Meteorology.—Forecasts, reports, etc., are received regularly and posted up on the aerodrome.

Customs.—The Customs Office is open daily from sunrise to sunset, including Sundays and holidays.

A plan of the aerodrome is appended.

3. *Other Aerodromes.*

GRAND BIGARD.—The military aerodrome situated 5 km. (3 miles) west of Brussels formerly known as *Berchem-Sainte-Agathe* has been renamed *Grand Bigard*.

4. *Cancellation of previous Notice.*

Notice to Airmen No. 112 of October 22, 1920, is hereby cancelled.

NOTICE TO GROUND ENGINEERS

(16) Renewals of Licences: Complete Sets of Notices Necessary

WITH reference to Notice to Ground Engineers No. 1 (Explanatory Statement), *all* ground engineers will in future, when applying for renewals of their licences, be required to submit proof that they have received a complete set of Notices to Ground Engineers issued up to date.

All ground engineers will be supplied regularly with free copies of "Notices to Ground Engineers" on application to the Secretary (C. of I.), Air Ministry, London, W.C.2.

REPORTS AND MEMORANDA

The following is a list of reports of the Advisory Committee for Aeronautics and its Sub-Committees, which have been published recently; they are obtainable from H.M. Stationery Office:—

AERONAUTICAL RESEARCH COMMITTEE.

INTERNAL-COMBUSTION ENGINE SUB-COMMITTEE REPORTS.

36. Installation of the Blowers. "Rateau" Turbo Compressor in the R.E. 8 Machine, working in conjunction with R.A.F. 4D Engine. June, 1918. (With Diagrams.) Price 1*s.* 6*d.*; post free 1*s.* 8*d.*

37. Investigations carried out at the Royal Aircraft Establishment on the Use of Blowers for Super-Charging Aero-Engines. June, 1918. (With Diagrams.) Price 1*s.* 4*d.*; post free 1*s.* 4½*d.*

50. Effect of Varying Surface Conditions on the Heat transferred through the Walls of a Steel Tube. April, 1918. (With Diagrams.) Price 6*d.*; post free 7*d.*

51. Spark Energy of Electrical Ignition Systems. (With Plates and Diagrams.) March, 1919. Price 9*d.*; post free 10*d.*

REPORTS AND MEMORANDA.

604. Skin Friction on a Flat Surface. (With Diagrams.) December, 1918. Price 4*d.*; post free 5*d.*

629. The Longitudinal Stability of "X" Aeroplanes. (With Diagrams.) December, 1918. Price 9*d.*; post free 10½*d.*

634. Flow in the Rear of a Triplane at Small Angles of Incidence. (With Diagrams.) July, 1919. Price 6*d.*; post free 7*d.*

639. Multiplane Interference Applied to Airscrew Theory. (With Diagrams.) September, 1919. Price 2*s.*; post free 2*s.* 2*d.*

640. Compressibility on High Speed Stream Line Motions The Effect of. (With Diagrams.) April, 1919. Price 9*d.* post free 10*d.*

646. Resistance Experiments on Floor Models of proposed Non-Rigid Airship Envelopes. (With Diagrams.) October, 1918. Price 3*d.*; post free 3½*d.*

656. Total Life and Drag of One-Twelfth Scale Model, B.E. 2E. (With Plate and Diagrams.) November, 1919. Price 9*d.*; post free, 10*d.*

657. A large Range Manometer for Wind Channel Work, Note on. (With Plate.) December, 1919. Price 4*d.*; post free 4½*d.*

658. Forces, Moments and Interferences on a one-twelfth Scale Model of B.E. 2E, fitted with R.A.F. 18 Wing Section. (With Diagrams.) November, 1919. Price 9*d.*; post free, 10d.

665. Method for Determining the Rotary Derivatives, Mq and Nr of Models. (With Diagrams.) January, 1920. Price 2*d.*; post free 2½*d.*

666. Landing of Aeroplanes (Part I). (With Diagrams.) February, 1920. Price 4*d.*; post free 5*d.*

667. Landing of Aeroplanes (Part II). (With Diagrams.) January, 1920. Price 6*d.*; post free 7*d.*

669. The Robinson Anemometer, Notes on. (With Diagrams.) January, 1920. Price 6*d.*; post free 7*d.*

671. Measurement of Turbulence in the Atmosphere by the Spreading of A Smoke Trail. (With Plates.) November, 1919. Price 4*d.*; post free 4½*d.*

Technical Report, 1916–17, Vol. II. With Appendices. (Diagrams and Plates.) Price 7*s.* 6*d.*; post free 8*s.* 6*d.*

[Previous lists appeared in FLIGHT, July 3, 1919; October 23, 1919; February 19, 1920; April 22, 1920; May 13, 1920; August 19, 1920; December 2, 1920.]

SOME POSSIBLE LINES OF DEVELOPMENT IN AIRCRAFT ENGINES*

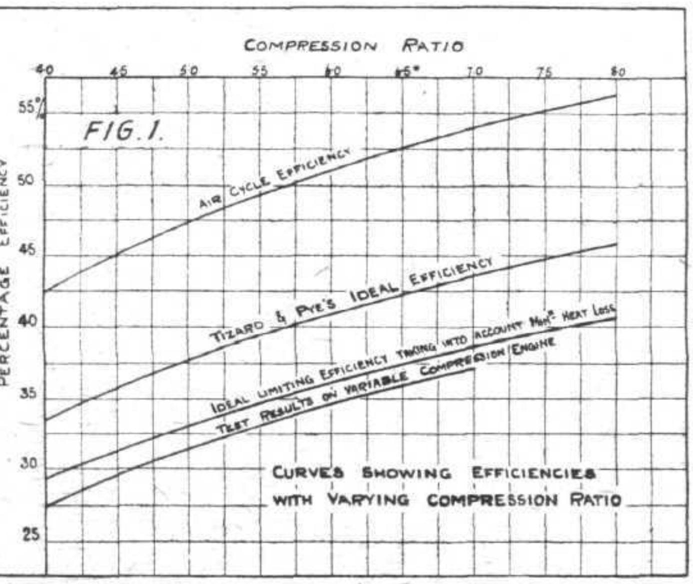
BY H. R. RICARDO

IF we review the present state of the art we find the position to be substantially as follows:—From a thermodynamic point of view the performance of the modern aero engine has approached so nearly to the ideal obtainable from the cycle on which it operates that there is little scope for improvement. To gain any further improvement it will be necessary either to depart from, or at least to take considerable liberties with, the accepted cycle, or to modify the composition of the fuel, or both. The theoretical efficiency of the cycle on which all present-day aero engines operate is given by the formula $E = 1 - \left(\frac{1}{r}\right)^{\gamma - 1}$.

This is known as the air standard efficiency; it assumes that the specific heat is constant at all temperatures, that there is no loss of heat and that there is no dissociation.

The most recent investigations on the properties of the working fluid carried out by Mr. Tizard and Mr. Pye and corroborated by the writer's experimental results, show that when due allowance has been made for the losses due to change of specific heat and to dissociation at the temperatures which actually obtain in the cylinder, the true limiting thermal efficiency becomes approximately $E = 1 - (1/r)^{0.295}$. This formula takes no account of the losses due to the direct passage of heat to the cylinder walls during combustion and expansion. In the most perfect case of an engine having a compact and symmetrical combustion chamber and running at a high speed, so that the direct heat loss during combustion and expansion is reduced to the absolute minimum, the highest attainable indicated thermal efficiency is given pretty accurately by the formula $E = 1 - (1/r)^{0.25}$. This allows for the minimum possible heat loss to the jacket walls, and may be regarded as the absolute limiting thermal efficiency obtainable under the best possible conditions, assuming:—(1) Perfect carburation and distribution. (2) That the compression and expansion ratios are equal. (3) That the mixture is homogeneous and of the most economical strength.

The following table (Table I) and the curves shown in Fig. 1 gives in column (1) the air-cycle efficiency for a range of compression ratios from 4 : 1 to 8 : 1, column (2) Tizard and Pye's ideal efficiency, taking into account losses due to change in specific heat at high temperatures and to dissociation, column (3) the highest attainable indicated thermal



efficiency assuming that the combustion chamber is designed to allow of the minimum possible heat loss, that the cylinder is of comparatively large capacity and that the revolutions are not less than 1,500 r.p.m. In column (4) are given the actual indicated thermal efficiencies as obtained in a special variable compression engine designed by the writer for research purposes, and in which every known artifice for obtaining the highest possible efficiency and power output has been employed. A photograph and sectional drawings of this engine are shown in Figs. 2, 3 and 4.

* Extracts of Paper read before the Royal Aeronautical Society on December 16, 1920.

TABLE I.

Expansion ratio.	Col. 1. $E = 1 - (1/r)^{0.4}$	Col. 2. $E = 1 - (1/r)^{0.295}$	Col. 3. $E = 1 - (1/r)^{0.25}$	Col. 4. Observed results variable compression engine.
4.0	0.4256	0.336	0.296	0.277
4.5	0.4521	0.359	0.314	0.297
5.0	0.4747	0.378	0.332	0.316
5.5	0.4944	0.396	0.348	0.332
6.0	0.5116	0.411	0.361	0.346
6.5	0.5270	0.424	0.375	0.360
7.0	0.5398	0.437	0.386	0.372
7.5	0.5534	0.449	0.396	0.383
8.0	0.5647	0.460	0.406	—

The difference between columns 3 and 4, indicate the scope left for improvement—it is very narrow.

So long as the recognised cycle is adhered to, in its entirety, the importance of raising the compression and therefore the expansion is obvious. Now when working with all fuels belonging to the general group known as petrol the compression pressure which can be employed is limited by the tendency of the fuel to detonate and ultimately to pre-ignite.

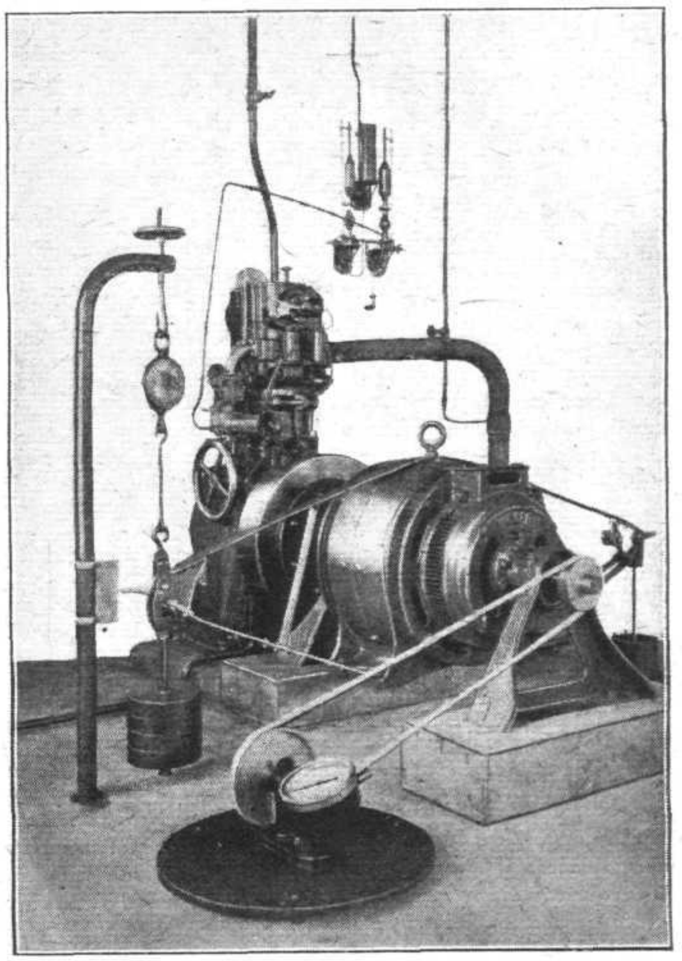
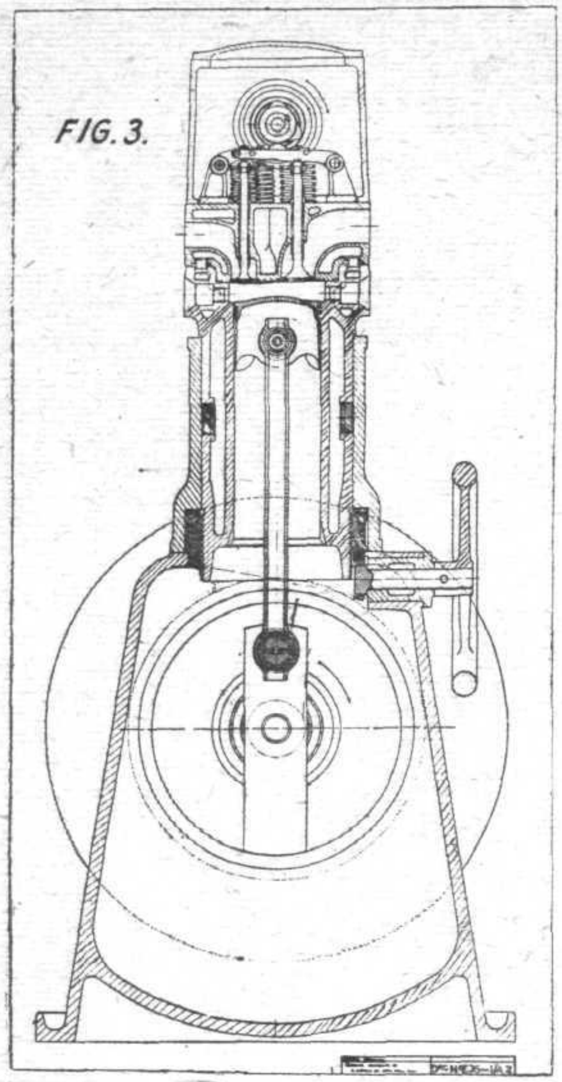
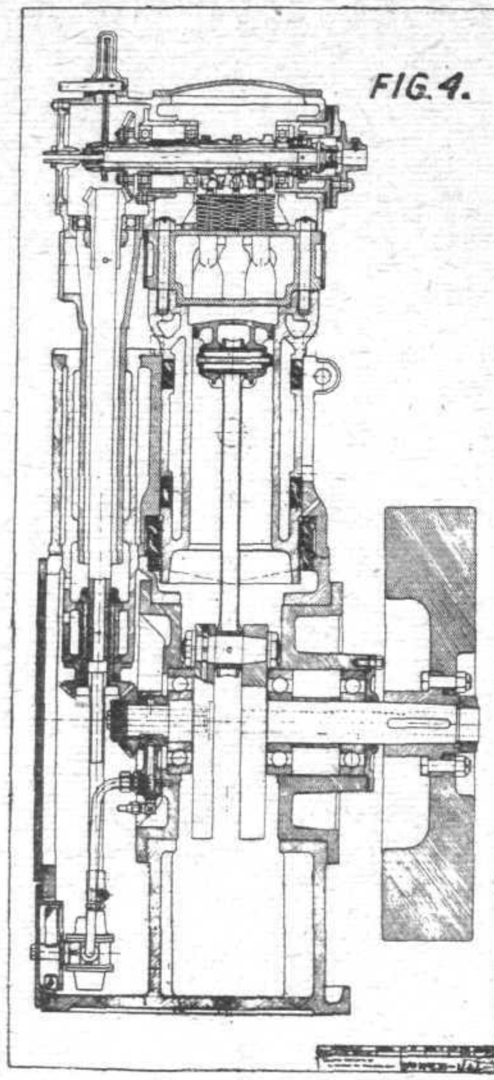


Fig. 2

It has been known for a long time that by adding benzole or benzene to paraffin petrols the tendency to detonate could be greatly reduced, but recent experiments at the writer's laboratory have shown that of these three members of the aromatic group, benzene is the least effective and toluene the most, while xylene occupies a position midway between the two. On account of their relatively low heat value per lb. it is naturally desirable to employ as small a proportion of aromatics as possible. Of the three aromatics mentioned, benzole has also the highest specific gravity and the lowest heat value per lb. It is therefore from every point of view the least efficient of the three.





Experiments on the variable compression engine have shown that the compression pressure can be raised in direct proportion to the aromatic content of the fuel. A light petrol freed from aromatics and consisting mainly of fractions of the paraffin series, but conforming in every respect to the Air Ministry's specification for aircraft spirit, detonates under normal conditions as to temperature, etc., and with the most efficient mixture strength and ignition timing at a compression ratio of 4.85 : 1 (the degree of compression at which detonation starts being very sharply defined). By adding 20 per cent. of toluene the compression can be raised from 4.85 : 1 to 5.57 : 1, the gain in efficiency on actual test is found to be from 31.1 per cent. to 33.5 per cent., and in mean effective pressure from 131.8 lbs. per sq. inch to 140 lbs. per sq. inch. Now the addition of 20 per cent. toluene adds less than 2 per cent. to the weight of the fuel per unit of heat and permits of an increase in efficiency of 7 per cent. The net gain is therefore very considerable.

Finding toluene the most efficient medium for preventing detonation, it was decided to express the tendency of fuels to detonate in terms of their toluene value.

Starting with a light paraffin petrol, freed from aromatics, the relation between toluene value and the highest compression ratio which could usefully be employed was found to be as shown in the following table and the curves in Fig. 5 :—

Toluene value.	Compression ratio.	Ind. mean pressure as found by experiment.	Ind. thermal efficiency as found by experiment.	Limiting Ind. thermal efficiency.
0	4.85 : 1	132.5	0.311	0.327
10	5.20 : 1	135.4	0.323	0.338
20	5.57 : 1	138.7	0.335	0.350
30	5.94 : 1	142.0	0.347	0.361
40	6.32 : 1	144.9	0.355	0.371
50	6.67 : 1	147.5	0.365	0.380
60	7.05 : 1	150.0	0.373	0.388

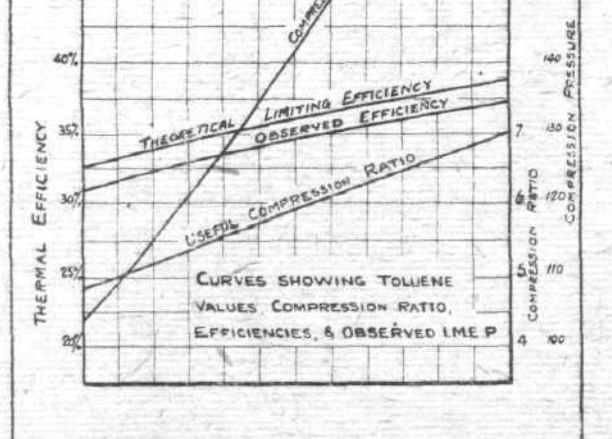
Later investigations showed that toluene was not the most efficient dope, and that, in fact, it could not compare with alcohol, though this fuel is not likely to be of much value for aircraft on account of its low heat value per lb.

The following table gives the toluene values of a number of different fuels. For permission to publish this table the writer in indebted to the Asiatic Petroleum Co., Ltd., for whom these and other investigations were carried out :—

	Toluene Value.
Toluene ..	.. + 100
Benzene ..	.. + 66
Xylene ..	.. + 83
Ethyl-Alcohol, 99 per cent.	.. + 166
Acetone ..	.. + 75
Cyclohexane	.. + 30
Carbon Bisulphide ..	.. + 10
Methyl Mercaptan	+ 5 to 10
Ether ..	.. − 60

From this table it will be seen that the fuel known as hectar and consisting of 50 per cent. benzene and 50 per cent. cyclohexane, which the Americans have found so successful, therefore has a toluene value of 48, and could be used with a compression ratio of 6.6 : 1.

Apart from varying the composition of the fuel, which is not always practicable, a somewhat similar increase in compression and therefore in efficiency can be obtained by the addition of inert gases which serve merely to delay the normal rate of burning. Experiments with pure aromatic-free petrol of toluene value 0 showed that the safe compression ratio could be raised from 4.85 to 1 up to 7.5 : 1 by the addition of cooled exhaust gas. Fig. 6 shows the relation between mean pressure, thermal efficiency and compression ratio, when just sufficient exhaust gas was admitted in each case to check detonation. Thus it is possible to improve the economy of an engine by as much as 6 per cent. without affecting its horse-power one way or the other, by the mere addition of exhaust gas, costing nothing, and adding nothing to the weight of the engine.

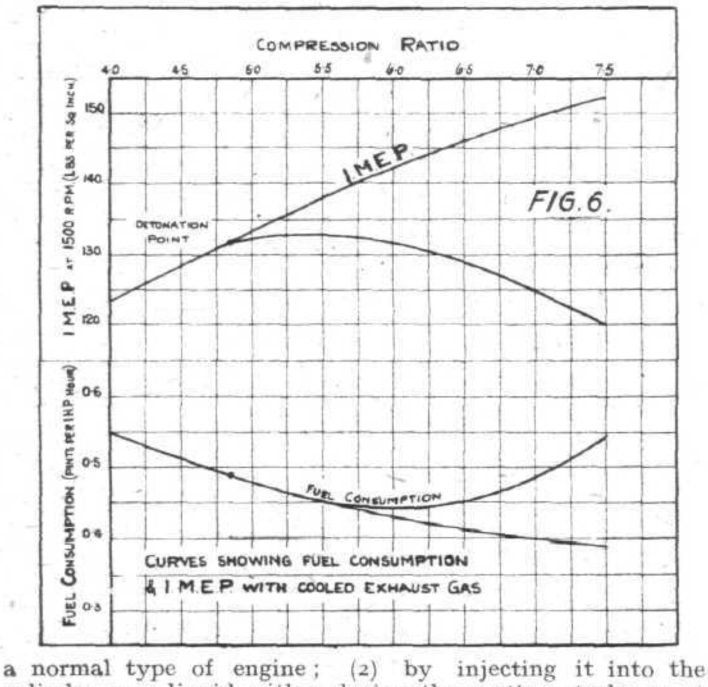


To appreciate the possibilities of the use of exhaust gas in this manner, let us suppose that we have a fuel of toluene value 0. With such a fuel the highest compression ratio we can use if the engine is to be capable of running "full out" at ground level, and with an economical setting, is only 4.85 : 1, corresponding to a limiting thermal efficiency of 32.7 per cent. By the addition of cooled exhaust gas a compression ratio of say 7 : 1 giving a limiting thermal efficiency of 38.6 per cent. could be used and still permit of the engine being run full out on the ground with perfect safety, and developing even at ground level very nearly the same power as the lower compression engine. As the machine ascended the quantity of exhaust gas would be reduced until at about 12,000 feet it could be cut off altogether.

By way of comparison, tests were run with varying compressions and with a fuel of toluene value 0 in order to ascertain the relation between mean pressure, compression pressure and compression ratio when detonation is prevented by throttling. The results obtained are shown in Fig. 7, and require no particular explanation. It is interesting to note, however, that detonation became apparent at very nearly the same compression pressure in all cases. By way of comparison it will be noted that with this fuel the throttled engine with 7 : 1 compression ratio can develop only 57 per cent. of its full power on the ground while the exhaust controlled engine can develop 84 per cent.

Safety Fuels.

A good deal of interest has been shown lately in the question of employing fuels of high flashpoint to avoid fire risks. So far as the writer is aware, kerosene only has as yet been seriously considered. There are two possible methods of dealing with this fuel, (1) by vaporising it and so using it in



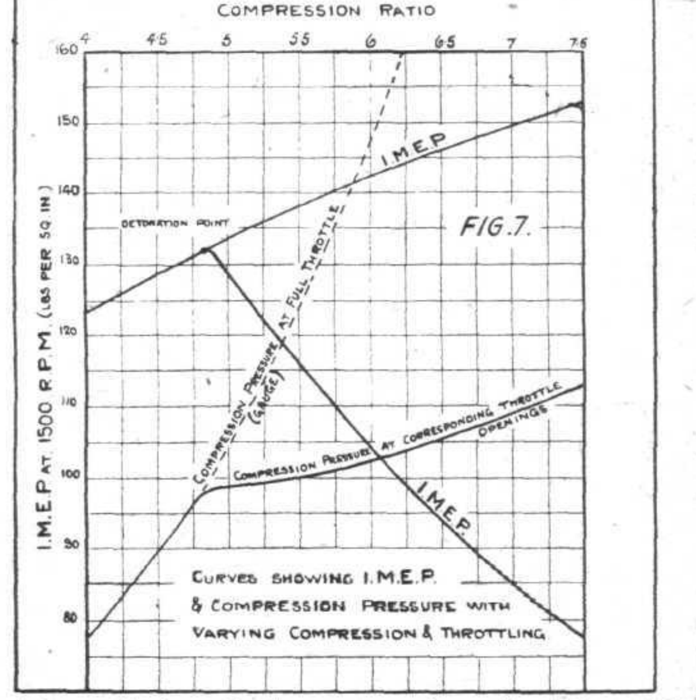
a normal type of engine; (2) by injecting it into the cylinder as a liquid, either during the suction stroke or at the end of compression.

With regard to the first method, commercial kerosene consists almost entirely of heavy fractions of the paraffin series. These are all chain compounds, and from the point of view of detonation kerosene is one of the most troublesome fuels in existence. Further, in order to vaporise a reasonable proportion of it, it is necessary to raise its initial temperature to certainly not less than 60° C. This means a reduction in the weight of charge of at least 20 per cent. Further, owing to its chemical instability on the one hand and the high compression temperature resulting from pre-heating, the limiting compression is reduced to about 4.2 : 1. Again, no means have yet been discovered of preventing the heavier fractions condensing on the cylinder walls and passing down into the crank-case, where they soon prove destructive to the bearings, etc. The alternative method of injecting the fuel is not much more hopeful so long as it is applied to the existing type of engine. If the fuel is injected on the suction stroke one avoids the loss due to pre-heating, and can therefore use a higher compression and obtain considerably higher power, but the condensation trouble becomes more serious than ever. Lastly, if the fuel be admitted at the end of compression and ignited on entry by means of a hot plate or other igniter, the very formidable difficulty of so pulverising and distributing the fuel that each particle can find at once the necessary air for complete combustion has got to be tackled.

There is, however, another way of dealing with the high flashpoint fuel problem which, in the writer's opinion, is the most hopeful at the moment. Many natural kerosenes contain a considerable proportion of heavy aromatic hydrocarbons having the same characteristics as regards flashpoint as the kerosene of which they form a part. Their use as a safety fuel for aircraft engines is worthy of careful consideration. Owing to their almost complete immunity from detonation they can be used with a very high compression ratio, even after pre-heating in a vaporiser. Experiments made with these aromatic extracts show that with an inlet temperature of 60° C. it is still possible to use a compression ratio as high as 6 : 1, and even 6.5 : 1, with the result that the efficiency is very high and the power output equal to or very nearly equal to that obtained with ordinary petrol of low toluene value. Direct comparative tests carried out with paraffin and samples of these aromatic extracts gave the following results:—Kerosene sp. gr., 0.812; I.M.E.P., 111.0; Fuel pt. per 1 h.p. hr., 0.595; aromatic extracts sp. gr., 0.884; I.M.E.P., 125.5; Fuel pt. per 1 h.p. hr., 0.42. In both cases exactly the same vaporiser temperature was used, the only difference being in the compression ratio.

Influence of Mixture Strength

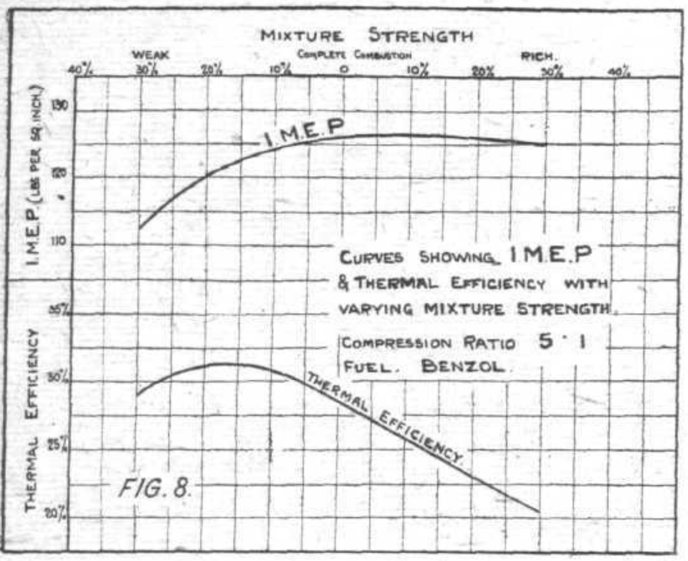
The writer has carried out on behalf of the Asiatic Petroleum Co., Ltd., a very large number of tests on about 40 different fuels in order to ascertain the relation between mixture strength, power and economy. The curve (Fig. 8) shows the relation between thermal efficiency and mixture strength expressed in terms of mean pressure. The example shown

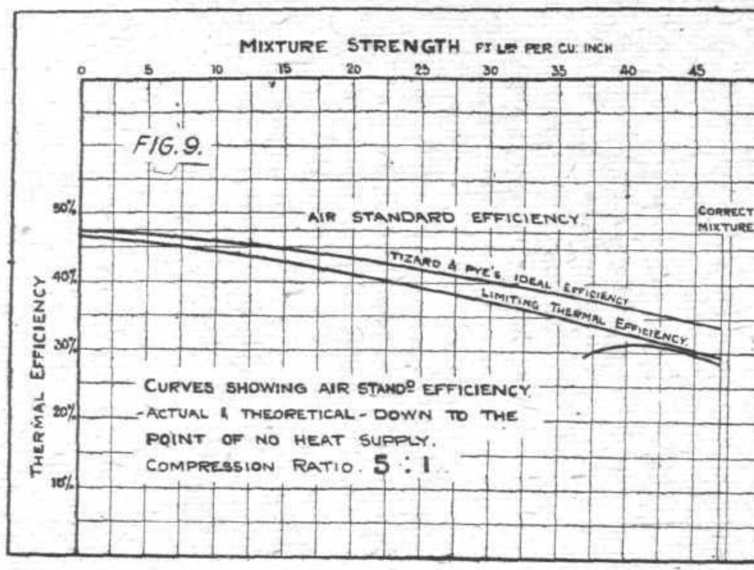


is taken with benzole at a compression ratio of 6 : 1 and, with but infinitesimal variations, it may be taken as applying to any fuel except alcohol. It will be observed that maximum efficiency is obtained when the mixture strength is such that the mean effective pressure is about 3 per cent. below the maximum. Now were it possible to control the power output by mixture strength alone, and still obtain complete combustion, it is clear that the maximum temperature would then be proportional to the load and would diminish as the load is reduced. The accompanying curve (Fig. 9) shows how, under these conditions, the limiting thermal efficiency would vary with the load. In this diagram the horizontal line denotes the air-cycle efficiency which, since it takes no account of heat losses, etc., is constant for all loads, the sloping line denotes the theoretical limiting efficiency over the range from no load to the full load, the third line represents the limiting efficiency with minimum heat losses, and the fourth the actual test results obtained over the range of mixture strength available with a homogeneous charge. While it is not possible to weaken the mixture strength so long as the charge is homogeneous, it is possible to do so by means of stratification, *i.e.*, by supplying the cylinder with a relatively small charge of combustible mixture and admitting separately a large charge of air, keeping the two apart until after ignition.

The accompanying curve (Fig. 10) shows the efficiency actually obtained in one experimental engine with a compression ratio of only 5 : 1. It will be observed that it rises

to no less than 37 per cent. at about one-third full load corresponding to a fuel consumption of just under 0.36 pint of benzole per indicated horse-power hour. It will be seen that the curve of efficiency actually obtained follows the theoretical curve with a reasonable degree of approximation. In Figs. 11–13 are shown some typical indicator diagrams taken from one of the two engines, with a Hopkinson optical indicator. It should be noted that when working on this system distribution troubles disappear. In any ordinary multi-cylinder engine it is necessary so to proportion the mixture that the weakest cylinder receives a charge of a certain minimum strength to ensure regular running; this means that other cylinders are receiving a slightly richer charge than is absolutely necessary and their efficiency is therefore reduced. On the other hand, when working with a stratified charge, the power output of each cylinder is dependent solely upon the quantity of fuel admitted to it, so that any cylinder which receives a richer mixture than others will develop correspondingly more power, and the economy will always be at a maximum, that is assuming, of course, that the mixture strength is at all times below that required to consume the whole of the oxygen. Again, from the point of view of altitude compensation nothing could be simpler, for (so long as the oxygen in the cylinder is not all consumed) constant power can be maintained over any reasonable range of density by merely supplying a constant fuel feed, *e.g.*, by gravity, or if a carburettor is used in its crudest form, the variation in power with altitude will correspond with the natural characteristic of the carburettor, and will therefore vary as the square root of the density.



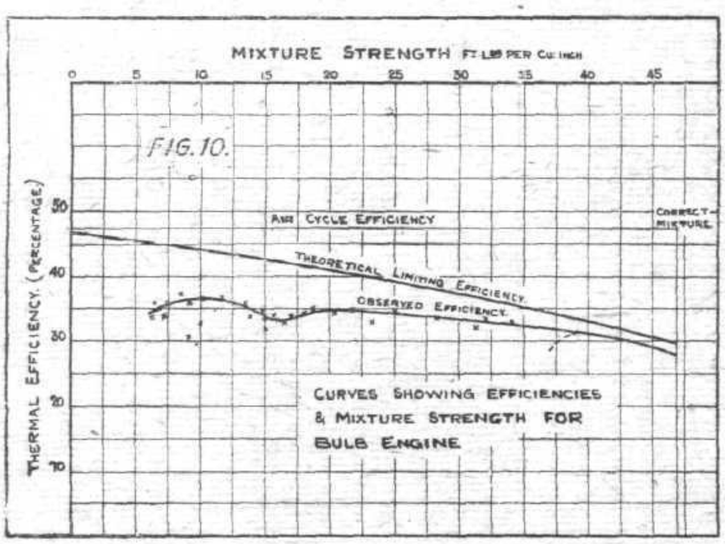


With a view to gaining further practical experience with this system, one of the two gas engines supplying power to the writer's laboratory was, about nine months ago, converted to run with stratified charge and control on the fuel alone. Since that date it has run continuously under violently fluctuating loads and has developed no trouble of any kind. It is running in parallel with another engine identical in every respect but working on the ordinary cycle. In the case of the latter engine it is necessary to remove the cylinder head every two months for decarbonising and grinding in the exhaust valve, while the cylinder of the engine working on the stratified charge has only been opened once, when it was found to be practically clean, while the exhaust valve appeared to keep almost as cool as the inlet valve in the other engine. As regards governing and regularity of running there is nothing to choose between the two engines, each of which can develop a maximum of 24 b.h.p. at 750 r.p.m.

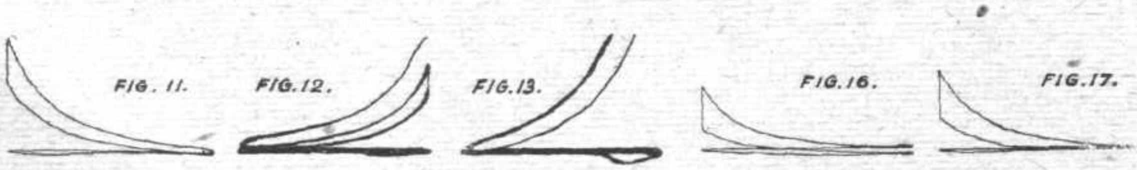
Although the above experiments suggest that the system has been developed to a practical stage, the writer feels that this is hardly yet the case, and that considerably more research is required before it can be considered wholly satisfactory.

In the writer's opinion the potentialities of working with a stratified charge cannot be over-estimated. It opens up the possibility of obtaining far higher efficiencies than are obtainable by any other known means, and, what is perhaps equally important, it reduces the temperature of the cycle and with it all the troubles due to high temperatures which directly or indirectly are the root cause of most mechanical failures Since the rate of heat flow to the cylinder walls varies roughly as the cube of the temperature, and the power output practically directly as the temperature, it follows that quite a small reduction in power will reduce the heat losses to an extent that must render air-cooling quite a simple problem.

The possibilities of working with a short compression and long expansion stroke deserve careful consideration. In effect this can be accomplished by the simple expedient of



closing the inlet valve late, so that compression does not start until well up the compression stroke; this method has both direct and indirect advantages. The direct advantages are that while the compression pressure is controlled by the nature of the fuel, the expansion ratio can be extended to any degree and very high efficiencies can be obtained, though, of course, at the expense of the power developed per unit of cylinder volume.

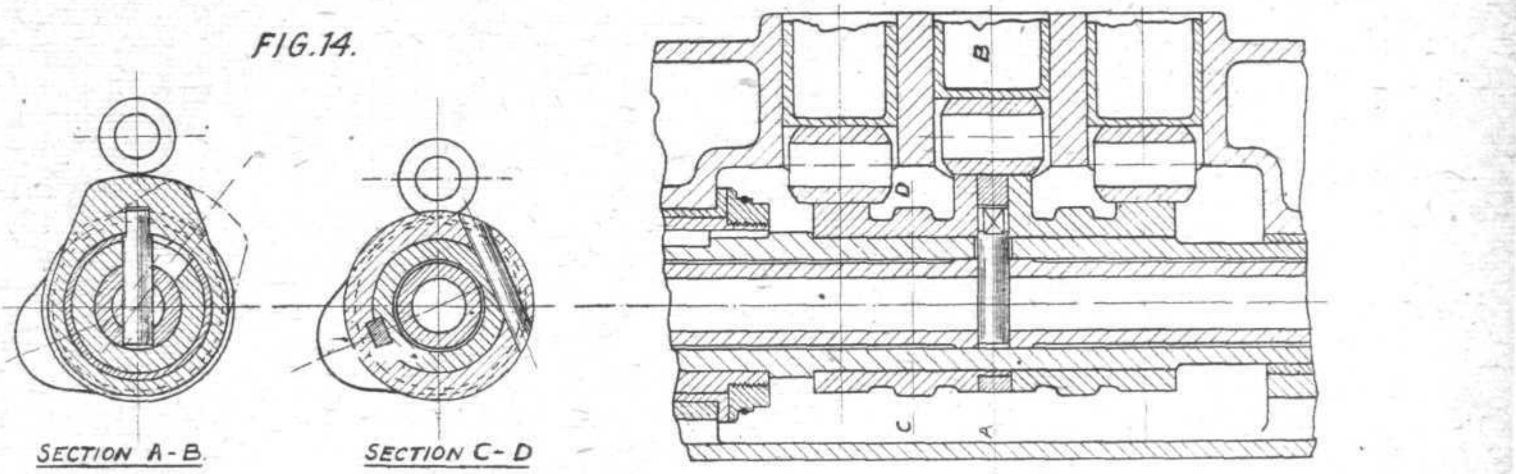


For example, suppose that a fuel of toluene value O is used, then while the compression ratio is limited to $4.85:1$ on the ground, the expansion ratio may be say $8:1$. The limiting efficiency for $4.85:1$ expansion is 32.7 per cent., and for $8:1$, 40.6 per cent. The power output under these

conditions will therefore be $4.85/8 = 60$ per cent. of that obtainable with an 8 : 1 compression, assuming that such a compression could be employed, or 73 per cent. of that obtainable if both compression and expansion ratio were 4.85 : 1. By varying the time of closing of the inlet valve the compression could be increased as the machine ascended, until at about 15,000 feet the full compression could be used and full power developed; thus the indicated thermal efficiency could be maintained at a maximum, and the power nearly constant over this range of altitude.

The indirect advantages are :—(1) That with such a valve setting the engine has a rising torque curve which is a desirable characteristic. (2) In the event of one cylinder dropping out and the speed falling in consequence, the compression in the remaining cylinders is reduced, and the shocks due to the irregular turning moment are also reduced. (3) When working with a late closing inlet valve the whole charge enters the cylinder and a portion is rejected. The rejected portion, which returns to the manifold, has picked up a considerable amount of heat from the inlet valves, cylinder walls and residual exhaust gases, some of which heat it imparts to the inlet manifold, with the result that, as the load is reduced, so is the temperature of the manifold increased, which is a desirable characteristic.

FIG. 14.



SECTIONS THROUGH CAM BLOCK

Some years ago the writer carried out a series of experiments with a patent variable inlet cam (shown in Fig. 14) fitted to a small experimental engine having an expansion ratio of 5.95 : 1. A number of very careful comparative power and consumption tests were made, the power output of the engine being controlled in the one case by varying the time of closing of the inlet valve, and in the other by using a normal valve setting and throttling the charge. The results obtained in these experiments are shown in Figs. 15, 16 and 17, from which it will be observed that the gain in efficiency in the former case, though perhaps not so large, is none the less quite appreciable. It should be noted that in these experiments the same expansion ratio was used in both cases, so that the advantage due to prolonged expansion was not obtained, and the gain in economy recorded is that due to indirect advantages alone.

In aircraft engines when one is working over a large range of atmospheric density the question always arises—at what density the engine shall be designed to give its best performance or at least to develop its full power. Until comparatively recently all engines were so designed that they could develop their full power at ground level, without pre-ignition, without overheating, and without overstressing the parts. During the War, however, it became evident that this was unnecessary and undesirable, and manufacturers were urged to design their engines on the assumption that they would not be opened full out below 10,000 feet. So far as the writer is aware, no manufacturers actually produced such an engine. It is, however, interesting to consider what might be done in this direction. We will begin with the assumption that modern aviation spirit has a toluene value of 10, which is about the average value of American aviation spirit. At 10,000 feet the air density is 0.72, and at this density a compression ratio of 7.0 : 1 could be used with such a fuel, giving a theoretical limiting thermal efficiency of 38.8 per cent. and a theoretical limiting mean pressure of approximately 165 lbs. per sq. inch reckoned at ground level or 119 lbs. per sq. inch at 10,000 feet. Under these conditions let us now consider what power the engine could develop at ground level, keeping just free from detonation. If controlled by throttling the maximum indicated mean pressure would be approximately 95 lbs. per sq. inch. If controlled by varying the time of closing of the inlet valve it would be considerably higher, because for various reasons the efficiency obtainable under these conditions is greater and would be very nearly in the ratio of $5.25 : 7.0 \times 165$ (5.25 being the limiting ground level compression ratio for a fuel of toluene value 10) or say about 122 lbs. per sq. inch. If controlled by the addition of cooled exhaust gas the mean effective pressure, as shown previously, would be very nearly equal to the full available M.E.P. with a compression ratio of 5.25 : 1 or 140 lbs. per sq. inch.

In all cases let us assume that the mechanical losses of the engine are equivalent to an M.E.P. of 15 lbs. (a fair average figure). Then the theoretical limiting brake mean pressure in the three cases would be :—(1) 80 lbs. per sq. inch; (2) 107 lbs, per sq. inch; (3) 115 lbs. per sq. inch, *while at 10,000 feet the brake M.E.P. will be 104 lbs. in all cases.*

In all three cases the explosion pressure would be substantially the same, and little or no higher than at 10,000 feet—that is about 450–500 lbs. per sq. inch. In the latter case it will probably be actually lower, because the principal effect of the exhaust gas is to slow down the rate of burning and so round off the peak of the diagram. Assuming that the propeller torque varies as the square of the speed and directly as the density, then, if the engine is designed to run all out at 10,000 feet at 1,500 r.p.m., its maximum speeds at ground level will be approximately 1,100, 1,270 and 1,320 r.p.m. respectively. In the former case such an engine would probably fail to leave the ground.

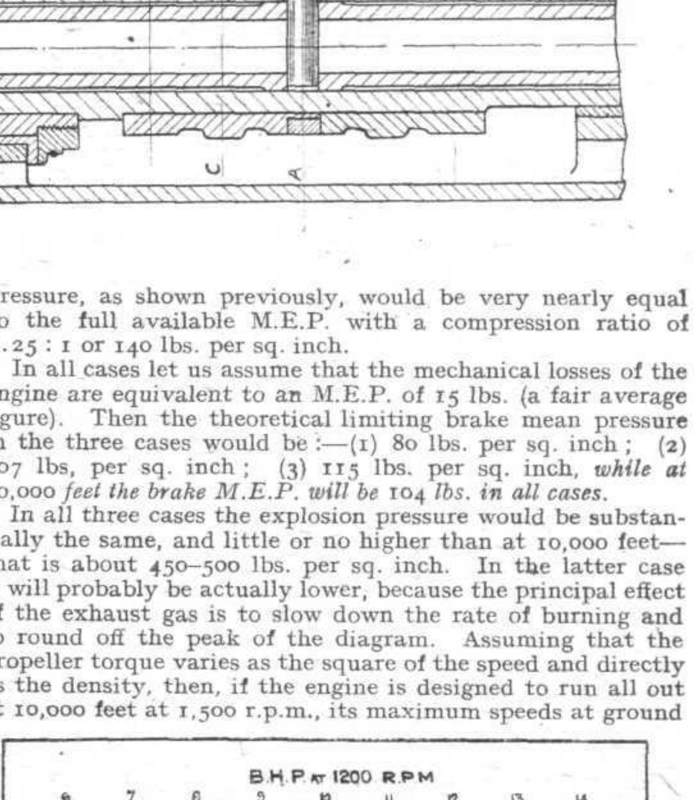


FIG. 15.

From these considerations it seems clear that the principle of designing a very high compression engine for use at high altitudes and throttling it on or near the ground is not the right one. Of the three methods considered, the use of exhaust products appears to be the most hopeful as a means of permitting a very high compression engine to operate satisfactorily at low altitudes, and still have sufficient power to get rapidly off the ground.

The alternative method of dealing with the problem of varying atmospheric pressure is to maintain artificially ground level density in the cylinder at high altitudes by supercharging.

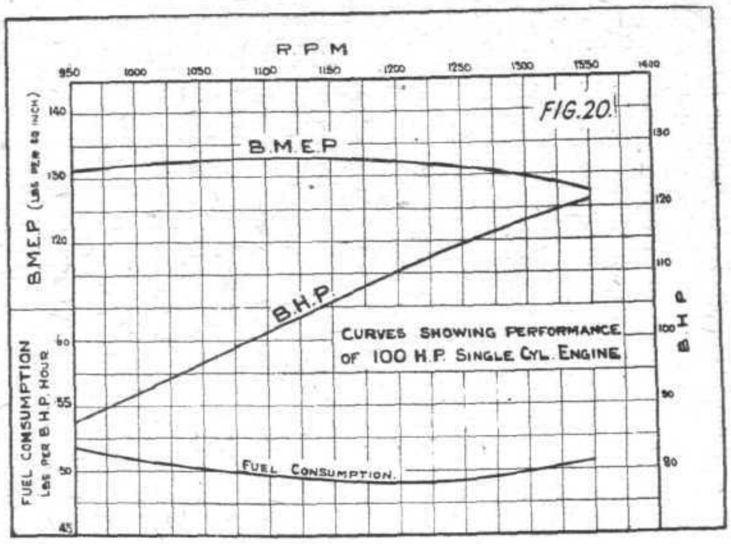
There are at least two possible ways of dealing with the

supercharging problem, one by merely forcing more fuel and air into the cylinder by means of a pump or blower and the other by employing a supercharge of pure air in a stratified form.

Some four years ago the writer carried out a very extensive series of tests on this latter system, and obtained most encouraging results on two experimental engines, but had to break off these experiments and concentrate all his attention on engines for tanks. The results obtained were, however, so encouraging that further tests should be made. Apart from the obvious increase in power at high altitudes this system of supercharging provides a perfect and automatic compensation of mixture strength for altitude, and gives a considerable increase in economy, the consumption falling from 0.49 lbs. per b.h.p. hour when running normally to 0.455 lbs. when supercharging.

Limiting Size of Cylinder

Designers of aircraft engines have, in the writer's opinion, shown quite unnecessary timidity in regard to the power output obtainable from individual cylinders. So far as the writer is aware, no one has yet had the courage to construct an aero engine with cylinders developing more than 50 h.p. each. Some 2½ years ago, as a result of experience with large cylinders on tank engines, the writer was requested or rather challenged by the Air Board to design an engine for aircraft to develop 100 h.p. per cylinder. A complete design was prepared and after much delay a single cylinder unit was built at Farnborough having a bore of 204 mm. and a stroke of 280 mm. This unit has now been running on and off for over a year. Apart from a rather mysterious failure of the valve gear at first, which has never been quite satisfactorily explained, it has given very little trouble, and no trouble at all which can be attributed to its large size. In view of the fact that its compression ratio is only 4.84 : 1 the results obtained are rather extraordinary and constitute, the writer believes, quite a record for so low a compression. From the accompanying curves, Fig. 20 (for permission to publish which the writer is indebted to the Superintendent of the Royal Aircraft Establishment), it will be observed that this single cylinder unit develops 120 b.h.p. when running at 1,350 r.p.m. with a consumption of only 0.493 lbs. per b.h.p. hour at its normal speed of 1,250 r.p.m. corresponding to an



indicated thermal efficiency of 31.2 per cent., or within 4 per cent. of the limiting value for this compression and an indicated mean pressure of 150 lbs. per sq. inch.

These results will, the writer hopes, help to dispose of the myth that very large cylinders can only operate with relatively low mean pressures and at a low efficiency.

AVIATION IN PARLIAMENT

Accident Statistics

IN the House of Lords on December 20 Lord Montagu of Beaulieu asked the Under-Secretary of State for Air if he could give any information about the recent accident at Hendon, whether he could secure by legislation or otherwise that there should be no trees or high obstructions in the close vicinity of public aerodromes, and whether he could give any statistics regarding the number of passengers carried, accidents, etc.?

Lord Londonderry said it was not possible to give the causes of the accident, which was being investigated by the Accidents Investigation Committee. When a Licence for an aerodrome was applied for it was personally inspected by an expert, who examined not only the area and surface, but also the approaches and obstructions from a flying point of view. Unless such approaches were considered safe the licence was refused. As to statistics he referred to the recent report on the Progress of Civil Aviation.

Royal Air Force

SIR F. HALL, in the House of Commons on December 20, asked the Prime Minister what economy would be effected by amalgamating the present separate administrations for War and Air Services; and if, in view of the urgent need for cutting down expenditure and the technical advantages of such a course, the Government will agree to the appointment of a Select Committee of the House to go into the matter?

The Prime Minister: It is the considered policy of His Majesty's Government to maintain a separate Air Service. The reason for this cannot be dealt with in answer to a question, but the subject can be fully discussed when the Air Estimates are presented next year.

Maj.-Gen. Seely: May I ask, if it be the policy of the Government to maintain a separate Air Service, why the right hon. gentleman does not have a separate Air Minister, so giving the Navy a chance of having the Air Service that they need?

The Prime Minister: My right hon. and gallant friend knows that that was very fully discussed some time ago, and we do not quite take the view that he puts forward.

Maj.-Gen. Seely: Can the right hon. gentleman deny that the Navy are seriously concerned at the lack of air power that they get under the present arrangement under which the giving of air power to the Navy rests with the Secretary of State for War? Can he deny that?

The Prime Minister: On the contrary, the First Lord of the Admiralty expressed himself as completely satisfied with the arrangements made.

Maj.-Gen. Seely: On that point, I am sure the right hon. gentleman was not present at the Debate at which the First Lord of the Admiralty stated exactly the opposite, and said that it was a temporary arrangement, which would not continue.

Mr. Speaker: No replies to Government answers are permitted at Question Time.

The Air Navigation Bill

IN the discussion in the Commons on the report stage of this Bill, Lieut.-Commander Kenworthy asked for an assurance that the provision which concerns trespass would be fairly administered in the rules laid down by the Air Council. An instance had been brought to his notice where low flying had been irritable to people. Mr. Billing asked for an assurance that in future no pilot, civil or military, should be allowed to leave the precincts of an aerodrome without having attained a minimum flying height.

Lieut.-Commander Kenworthy moved an amendment which would give municipalities power to run aircraft lines as well as establish aerodromes.

Mr. Billing seconded this proposal.

Mr. Churchill said that as far as he knew no municipality wished for such wide powers, and he thought it would be overweighting the Bill if they were to put upon every municipality the power to run an air fleet out of the rates. The amendment was negatived.

Mr. Churchill moved an amendment to Clause 9 with the object of making it clear that the owner has the right of recovery against the actual offender. For instance, if a passenger in an aeroplane threw out a bottle which damaged a city or a child, the owner of the aeroplane would have an action against such an unruly passenger. It might be also that a person might put himself in the path of an aeroplane and force the aircraft to swerve, and so run into a crowd of people. There are matters which would have to be decided by the Courts, and the presumption of negligence in the first place would be on the owner. This was agreed to.

Lieut.-Col. Moore-Brabazon, on the motion that the bill be read a third time, said that the Bill laid down what was so dear to the lawyer and what was so ridiculous in practice—the theory of *Usque ad Cœlum*—the ownership of the air infinitely upwards. We had given up our old ideas like territorial waters to a distance of three miles; here we were going on for ever. Many of them who had hoped that in the air there was a medium of true internationalism had been disappointed by the deliberations of the International Commission. In the first article was laid down this exclusive sovereignty over the air, but then there was a shred of hope—a pious resolution which said:—

"Each contracting State undertakes in time of peace to accord freedom of innocent passage above its territory to the aircraft of the other contracting States."

That meant that we could fly from one end of the earth to the other. But immediately after comes in the direction, which said:—

"Provided that conditions laid in the present Convention are observed,"

so that we were in that ridiculous position of not being able to fly across Europe without landing at every small State we had created since the War. There was also created in this Convention a new body in which there is very great hope, namely, what is called the I.C.A.N.—the International Commission for Air Navigation. Although it had the most astonishing powers and would become more useful year by year, yet there had been made the mistake in this Convention of mixing the whole thing up with the League of Nations. The Convention has nothing whatever to do with the League of Nations. It was a much more practical body than that. He protested against what he described as a conspiracy against our late enemies. We had it that no one who was a late enemy could come in until 1923, and even after that could only come in with a three-fourths majority. This was an arrangement which hurt us much more than it hurt Germany in preventing her coming in. Germany had had lately a real blessing imposed upon her. We had destroyed all her engines and all her aircraft, with the result that she started fair today with that great blessing of new ideas and not old machines. That was what we had suffered from in this country, and what had ruined in a large way our own civil aviation.

Lieut.-Commander Kenworthy said he only wanted to ask one question. Could any hope for subsidising aircraft suitable for war purposes for civil aviation be held out?

The Bill was read a third time.

Engines for R.A.F.

CAPTAIN BOWYER on December 21 asked the Secretary of State for War what was the total cost of the 14,800 aero engines on order at the date of the Armistice; how they have been disposed of; as to how many of these construction had not actually started on the date of the Armistice; and why he did not cancel those not begun, paying the resultant damages, if any?

Mr. Churchill: This question should have been addressed to the Secretary of State for Air. The approximate total cost of the engines taken delivery of since the Armistice is £15,000,000. Engines of certain types have been retained for the use of the Service, others have been disposed of to Dominion Governments or handed over to the Disposal Board of the Ministry of Munitions. The figure 14,800 is not that of the number of engines on order at the time of the Armistice, which was much greater—it is the number which the contractors were allowed to complete under their contracts. It is impossible to say how many of these engines had not been commenced at date of Armistice, but in every case the Liquidation Committee of the Ministry of Munitions settled on the best terms available, the number of engines to be completed, and the compensation to be paid for cancellations.

AIRISMS FROM THE FOUR WINDS

THE latest rain-making proposition per aeroplane comes from Port Arthur. Firing of cannon or the use of bombs are exploded—in more senses than one—ideas. This time the creation of showers is to be brought about by spraying liquid air from an aeroplane, thereby causing the moisture in the atmosphere to condense and fall to earth. This ingenious scheme is the considered plan of Mr. A. E. Cole and his son Capt. Horner Cole, an ex-R.A.F. officer, and it is stated they have started a company at Port Arthur to prove their theory.

A STATEMENT by Sir Percy Scott has been "guyed" in relation to the Capital Ship *versus* Submarine and Aircraft controversy, suggesting that if capital ships are to be still the backbone of our power, roofed harbours will be necessary to protect them from aircraft, in addition to submarine-proof harbours. Whether Sir Percy when he made it intended to be serious or merely facetious is not quite apparent, but is he so very far out in reality? As a fact, as a correspondent points out, at Bruges, a roofed harbour exists, constructed by the Germans in 1915—"a very substantially roofed harbour in which they kept their submarines." Moreover, the correspondent affirms, a Belgian officer informed him the Germans had heavily roofed-in harbours for Zeppelins. And why not? Some years back was published with drawings in FLIGHT the suggestion that in the future these aircraft "harbours" might well be vast excavations in the sides of hills or mountains. And, apparently, it was so.

EARLY in the New Year, so it is authoritatively rumoured, details of the Territorial Air Force scheme will be announced. Better late than never, although we fear many of the enthusiasts will have passed away to other climes by now, so that the organisation of this vital force will have to start from a very thin datum line. We only hope we may be proved to be horribly wrong.

REMARKABLE is the War record of Messrs. Vickers, Ltd., as set forth in the accounts of this great organisation just issued for the four years ending 1919. The figures therein are so colossal that it is difficult for the ordinary uncommercial mind to grasp their significance. Yet with all these magnificent efforts in helping toward the Allies' victory, it cannot be said they were guided by the mere making of profits. Indeed, considering, the final margin spells anything but profiteering. When those who directed this prodigious firm's efforts look back upon their record they may well be satisfied to leave it to posterity to number them amongst those who helped to make history. Of more immediate interest to readers of FLIGHT are the totals relating to aircraft. These embrace the construction of three large and six smaller airships of the rigid type, 26 kite balloons, 3,500 aeroplanes, 167 flying-boats, and through their Wolseley works 4,165 aeroplane engines! Prodigious! One hardly wonders that the "workers" during the period drew the bagatelle of 46 million 230 thousand pounds.

FOR the batches of Christmas and New Year's greeting cards to hand from our readers we return sincere thanks, with heartiest reciprocation for all the good wishes expressed. It is nevertheless surprising that in these very grey days of aviation there are so many who have sufficient vim remaining to energise them into such an effort of Mark Tapleyism as to imagine there is anything in the shape of real Yuletide festivity in these dreary times of desperation and taxes. May the silver lining begin at last to show in the coming year of 1921 for Aviation and the World in General.

QUITE an excellent idea has been put forward in France in relation to the great Buc Aviation week. In order that the gospel of aircraft may be spread as widely as possible, the suggestion is that instead of always holding this important fixture at Buc, the *venue* should be changed to various great centres, thereby letting the different provinces of France see what is being actually done in aviation progress. By way of instance, Marseilles is named for the meeting in 1922, as that year the city authorities are holding a great Colonial Exhibition. An air meeting should, therefore, under those circumstances, be doubly of value. The idea has been favourably received, and a similar series of fêtes in this country might well serve to revive interest in flying, which, by reason of Government indifference, has got to a very small focus in the eyes of the general public.

FROM correspondence to hand, several readers appear to have missed Mr. G. de Havilland's important letter in the general Press, to which reference was made in one of our leaders on December 16. We therefore, by request, reproduce below the original communication in full:—

"The difficulties which beset aircraft transport companies are causing pessimistic views to be put forward which are not justified. Aeroplanes can now do five-ton miles per gallon of petrol of net freight at 100 to 120 miles per hour when filled up for a 350-mile journey. The initial cost of an aeroplane of this type at the present high prices is about £6,000, and its gross earning capacity at full load is between £150 and £200 per day. Depreciation was at first assumed to be 50 per cent. per annum. Experience has shown that 20 per cent. per annum is probably too high, and it is now obvious that the rate of depreciation and cost of upkeep can, in the near future, be made less per ton-mile than that for a motor-lorry. These figures do not rely on a future type of aeroplane, but on one which has been in hard service for some months. It will be seen that the aeroplane is as economical as a motor-lorry, and has at least 100 miles per hour greater speed.

"The future of civil aviation is so obviously great as to need no pointing out. The present difficulties have nothing to do with the inherent capabilities of aircraft as a means of transport, but are due to many causes, such as the use of unsuitable converted military machines, the cost of pioneer work, the entire absence to begin with of load, and the gradual building up of a new industry. Most of this preliminary work is now accomplished, but resources have been used up in the process, and the results obtained show that any transport company which is able to obtain the very moderate capital which would enable it to obtain modern commercial aeroplanes and ruthlessly scrap unsuitable material is assured of immediate and increasing success. Government assistance of the kind which has been proposed, *i.e.*, a subsidy based on the amount of the gross takings, would certainly help things over a difficult period. The present difficulties are those which might attach to the commencing of any totally new industry; they are not inherent or technical."

THE closer all meteorological bodies and students can work together, the better for the plotting of the air. We therefore welcome an announcement from Edinburgh which states that on December 17 the Scottish Meteorological Society, which was founded in 1856, was brought to an end when the members, at their annual meeting, unanimously agreed to amalgamate with the Royal Meteorological Society.

Dr. C. S. Knott, the president, read the annual report, which stated that under an agreement between this society and the Meteorological Committee, which awaited confirmation, the Society agreed to hand over its library to the committee in trust for the maintenance of a meteorological library in Edinburgh. Further, it has been agreed that an advisory committee for Scotland should be set up representative of the universities, learned societies, and public departments, with the director of the Meteorological Office as chairman. This society had been successful in putting on a sound and permanent footing a meteorological organisation for Scotland, but they now believed that the best interests of the science would be served by amalgamation with the Royal Meteorological Society.

WHATEVER may be the outcome of the capital ships, submarine and aircraft agitation for future defence and ensuring our supremacy in air and water, the following contribution to the discussion of a "nursery rhyme" from "Naval Staff Officer," defining the functions of the Capital Ship, in reply to Sir Percy Scott's query, "What is the Use of a Battleship?" is distinctly funny and original. Thus it is:—"The ship that sinks the enemy's capital ship, that protects the cruisers that sink the cruisers which protect the destroyers, that sink the submarines that attack the merchant ships, that bring the food that feeds the people who build the ships that transport the army that defends the house that Jack built—the British Empire!"

THE ROYAL AIR FORCE

London Gazette, December 14

Flying Branch

Sec. Lieut. V. U. T. Watson to be Lieut.; April 11, 1919 (since demobilised, Pilot Officer C. P. Primrose to be Flying Officer; Sept. 14, 1919 (since demobilised). Lieut. A. J. Allen relinquishes his temp. R.A.F. commn. on appointment to the T.F., and is permitted to retain his rank.

The following Lieuts. relinquish their temp R.A.F. commns. on appointment to the T.F. Reserve, and are permitted to retain their rank:—G. Hall, H. B. Macdonald, D. Wilson.

Transferred to Unemployed List.—Lieut. S. G. Hollingsworth; May 28 (substituted for *Gazette*, June 4). Lieut. F. C. Daniel; Oct. 13. Lieut. (Hon. Capt.) P. E. Bishop, Lieut. H. C. Young, A.F.C.; Dec. 7.

Lieut. W. G. L. Bodley relinquishes his commn. on account of ill-health caused by wounds, and is permitted to retain his rank; March 6 (substituted for *Gazette*, March 5). Lieut. P. K. Glazebrook relinquishes his temp. R.A.F. commn. and is permitted to retain his rank. Lieut. C. De Bus Pequegnat relinquishes his temp. R.A.F. commn. The surname of Lieut. N. Boucher is as now described, and not as stated in the *Gazette* of Nov. 19. The notification in the *Gazette* of Dec. 3 concerning Lieut. S. G. Hollingsworth is cancelled.

Technical Branch

Pilot Officer J. S. Ferguson to be Flying Officer (Grade B), without pay and allces. of that rank; Nov. 22, 1919). Lieut. C. B. Harris relinquishes his temp. R.A.F. commn. on appt. to the T.F. Reserve, and is permitted to retain his rank.

Transferred to Unemployed List.—Capt. J. A. Nye; Aug. 1, 1919 (substituted for *Gazette*, Feb. 3). Lieut. H. Day; April 14. Lieut. H. C. Hull; Dec. 3.

The notification in the *Gazette* of Oct. 19 concerning Lieut. R. Hodge is cancelled.

Memoranda

Eighteen Cadets are granted hon. commns. as Sec. Lieuts. with effect from the date of their demobilisation.

Maj. P. G. Edge, O.B.E., relinquishes his temp. R.A.F. commn. on appt. to the T.F. Reserve, and is permitted to retain his rank. Capt. A. J. Child, O.B.E., M.C., relinquishes his temp. R.A.F. commn. on appt. to the T.F. Reserve, and is granted the rank of Lieut.-Col. Hon. Sec. Lieut. B. Cloke relinquishes his temp. R.A.F. commn.

London Gazette, December 17

Permanent Commissions

The following are granted permanent commns. in the ranks stated with effect from the dates indicated, retaining their seniority in the substantive rank last held prior to the grant of this commn.:—

Squadron Leaders.—J. S. T. Bradley, O.B.E.; Sept. 16, 1919. J. W. Cordingley, O.B.E.; Nov. 28, 1919. W. S. Douglas, M.C., D.F.C.; March 30. R. P. Willock; Sept. 12, 1919).

Flight Lieutenants.—F. H. Coleman; Oct. 24, 1919. G. H. Hooper, M.C., D.F.C.; Dec. 12, 1919. J. C. Slessor, M.C.; March 9. T. Q. Studd, D.F.C.; Oct. 24, 1919.

Flying Officers.—J. F. T. Barrett; Sept. 16, 1919. A. C. Bayley; Oct. 24, 1919. A. J. E. Broomfield, D.F.C.; Sept. 12, 1919. W. R. Cox, M.C., A.F.C., G. S. Hodson, A.F.C., H. T. Lydford, A.F.C., S. L. Quine, M.C., A. R. M. Rickards; Oct. 24, 1919. R. C. Savery, D.F.C.; Sept. 12, 1919. E. E. Turner, D.F.C., W. M. Yool, Oct. 24, 1919.

Gazettes of the dates indicated above, appointing these officers to short service commns. are cancelled:—

Flying Officer C. R. Fenton, M.C., resigns his permanent commn., and is permitted to retain the rank of Lieut.; Dec. 8.

The notification in the *Gazette* of Aug. 1, 1919, appointing Flight Lieut. D. H. M. Carbery, M.C., D.F.C., to a permanent commn. is cancelled.

Stores Branch

The following are granted permanent commns. in ranks stated, with effect from the dates indicated, retaining their seniority in the substantive rank last held prior to the grant of this commission:—

Flight Lieuts.—W. Burkinshaw; Dec. 1. V. J. Jacobs; June 17. C. A. Shaw, D.S.O.; June 17. T. A. G. Hawley (previously known as A. Hawley); July 20.

The following are granted permanent commns. in the ranks stated, with effect from the dates indicated, retaining their seniority in the substantive rank last held prior to the grant of this commn., and are transferred to the Stores Branch, with effect from June 17:—

Flying Officers.—A. S. Berry; Sept. 12, 1919. C. J. Elliott; Sept. 12, 1919. W. C. Green, M.C.; Sept. 16, 1919. V. S. Holbrook; Nov. 11, 1919. R. H. Latham; Oct. 24, 1919. S. G. Linssen; Sept. 12, 1919. W. G. MacD. Nicholl; Nov. 11, 1919. E. A. Tottle, Nov. 11, 1919. A. P. Woollett; Sept. 12, 1919.

Gazettes of the dates indicated above, appointing these Officers to Short Service Commissions, are cancelled.

Short Service Commissions

The following are granted short service commns. in the ranks stated, with effect from the dates indicated, retaining their seniority in the substantive rank last held prior to the grant of this commn., except where otherwise stated:—

Flight Lieutenants (for four years on the active list).—F. Fernihough, M.C. (Dec. 3). T. Henderson, M.C., A.F.C.; Nov. 30.

Flying Officers.—S. A. H. Bowyer; Dec. 10. C. C. Clark; Oct. 24, 1919 (substituted for notification in the *Gazette* of that date). P. Chauncy; Nov. 24. J. Durward; Dec. 7. C. W. Hill; Dec. 6 (for four years on the active list). K. Loughlin; Nov. 29. E. H. Oxley-Boyle; Nov. 26 (for four years on the active list). J. F. Stallard; Nov. 17. R. S. Walter; Nov. 24.

Pilot Officer on Probation.—R. E. Baugh; Oct. 30 (and with seniority of that date).

The name of Flying Officer Wilfrid Carnac, M.B.E., is as now described, not Wilfrid John Rivett-Carnac, as in the *Gazette*, Oct. 8.

Squadron Leader E. M. Bettington resigns his short service commn., and is permitted to retain the rank of Maj.; Oct. 10 (substituted for *Gazette* Nov. 9).

Flying Branch

A. E. S. Barton (temp. Lieut. R.F.A., T.F.) is granted a temp. commn. as Sec. Lieut. (O.); April 1, 1918, and to be Hon. Lieut. Lieut. (Hon. Capt.) R. G. Kitson relinquishes his temp. R.A.F. commn. on appt. to the T.F. Res., and is permitted to retain the rank of Capt. Lieut. (actg. Capt.) R. M. H. Young relinquishes his temp. R.A.F. commn. on appt. to the T.F. Res., and is permitted to retain the rank of Capt. Lieut. E. Steele, M.C., relinquishes his temp. R.A.F. commn. on appt. to the T.F., and is permitted to retain his rank.

Transferred to Unemployed List.—Sec. Lieut. (Hon. Lieut.) C. H. Stewart, M.C.; Jan. 19, 1919. Sec. Lieut. C. W. Pethick; May 21, 1919 (substituted for *Gazette*, May 20, 1919). Sec. Lieut. (Hon. Lieut.) A. E. S. Barton; Sept. 1, 1919. Sec. Lieut. H. MacD. Keith; Oct. 12, 1919 (substituted for *Gazette* Oct. 14, 1919). Lieut. J. R. Patterson; March 15. Capt. (Hon. Maj.) M. C. Brotherton; June 18.

Lieut. E. Stubbs relinquishes his temp. R.A.F. commn.

Sec. Lieut. R. R. E. Dimmick relinquishes his temp. R.A.F. commn., and is permitted to retain his rank.

Administrative Branch.

Flying Officer H. B. Shepheard (Lieut. L.N. Lancs. R.) relinquishes his temp. commn. on return to Army duty; Oct. 28. Maj. R. Inglis, D.S.O., relinquishes his temp R.A.F. commn.

Gazette, April 27, wherein Lieut. T. E. Turner was reclassified from (T.) to (Ad.) is cancelled.

Technical Branch

Transferred to Unemployed List.—Lieut. (Hon. Capt.) G. H. Salaman March 17. Capt. E. I. Sycamore; Sept. 15, 1919. Capt. G. F. T. Collender Dec. 17.

Memoranda

One Cadet is granted an hon. commn. as Sec. Lieut. with effect from date of his demobilisation.

London Gazette, December 21

Permanent Commissions.

Flying Officer T. A. G. Hawley (previously known as A. Hawley) is granted a permanent commn. in the Stores branch, retaining his present susbtantive rank and seniority; July 20 (substituted for *Gazette* Dec. 17). Flight-Lieut. F. W. Hudson, D.F.C., is placed on retired list; Dec. 22.

Short Service Commissions.

Flying Officer A. J. Dawes resigns his short service commn. and is granted rank of Major; Dec. 22. Flying Officer W. G. Murray resigns his short service commn. and is granted rank of Capt.; Dec. 22.

Flying Branch

Flying Officer S. M. Kinkead, D.S.O., D.S.C., D.F.C., is placed on half-pay list (Scale B); Dec. 23. Lieut. B. Adie relinquishes his temp. R.A.F. commn. on appointment to the T.F., and is permitted to retain his rank. Lieut. G. C. Shortridge, M.B.E., relinquishes his temp. R.A.F. commn. on ceasing to be empld.; Dec. 18.

Transferred to Unemployed List.—Sec. Lieut. F. E. Thomson; Feb. 7, 1919. Lieut. V. U. T. Watson; June 14, 1919 (substituted for *Gazette* Sept. 9, 1919. Lieut. O. D. Norwood relinquishes his temp. R.A.F. commn.

Administrative Branch

Pilot Officer W. O'Donoghue to be Flying Officer; Sept. 1, 1919 (since demobilised). The notification in *Gazette* Feb. 21, 1919, concerning Pilot Officer W. O'Donoghue is cancelled.

CORRESPONDENCE

The Editor does not hold himself responsible for opinions expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for insertion in these columns

AERO ENGINE'S STRENUOUS TEST

[2036] Safety in flying depends on the reliability of the engine. It is, therefore, to the engine manufacturers that one must look for producing an engine capable of withstanding the most strenuous tests, whose reliability will popularise flying.

Realising the responsibility of the engine, we have always carried out the most strenuous tests and trials with the 450 h.p. Napier aero engines—the same type as gained for the Vickers-Viking, Handley Page and Westland Aircraft the highest prizes in each of the three classes in the recent British Air Ministry Competitions.

We have just completed an even more thorough and strennous British Government type test with the 450 h.p. Napier aero engine. This test consisted of running the engine for 50 hours; after which it was put to a further 5 hours test of an even more arduous nature, viz.:—

High speed test of—

1 hour at 2,390 revs. per min. at 352 b.h.p.

High power test of—

1 hour at	2,100	revs. per min. at	454.5	b.h.p.
1	,,	2,015	,,	457	,,
1	,,	2,225	,,	532	,,
1	,,	2,026	,,	490	,,

It will be seen that for one hour this aero engine was run at the remarkably high horse-power of 532, which is a wonderful performance for an engine built to develop 450 h.p.

At the conclusion of the test—more strenuous than the engine may ever be put to in actual flying—it was running perfectly, and ready for further service.

H. T. VANE.

Managing Director, Napier and Sons, Ltd.

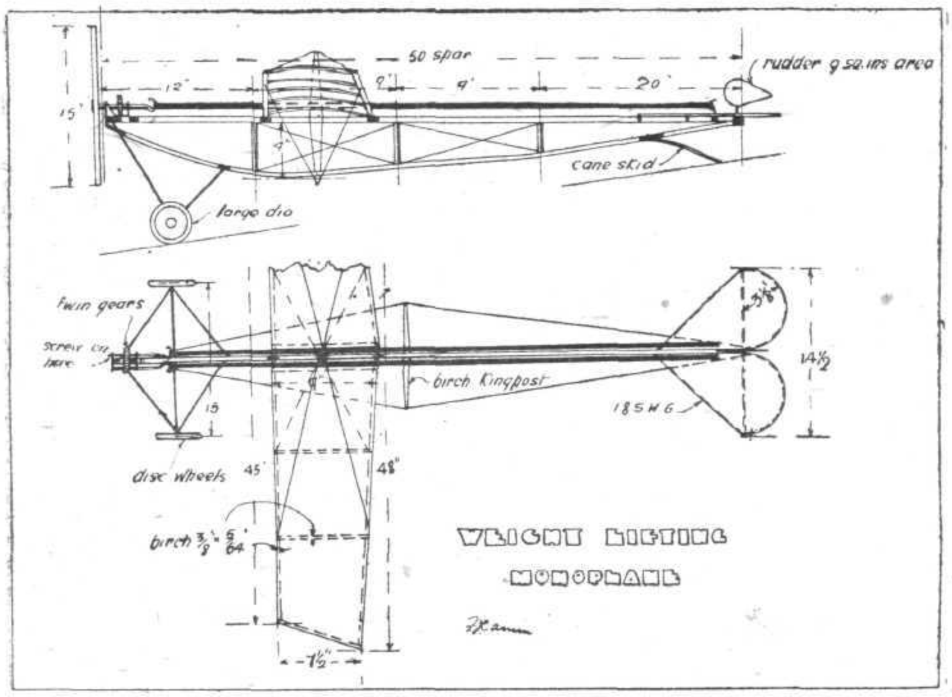
14, New Burlington Street, London, W.1.

December 21, 1920.

NOTE.—All communications should be addressed to the Model Editor. A stamp should be enclosed for a postal reply

Weight-Lifting Monoplane

THE drawings show the weight-lifting monoplane built and flown by the writer. Its best duration loaded was 35 secs., *unloaded* 28 secs. The undesirability of too light a loading is manifest from these results. The loading in this instance with the dead weight was 6 oz. per square foot, and the dead weight was 4 oz. (the rules of the competition for which it was intended stipulating that the dead weight must equal a quarter of the total weight of the machine, the minimum weight of the latter to be 1 lb.). It flew much better with the dead weight than without it, nor could it be coaxed into at east equalling its loaded performance when unloaded. I do not think that a lighter loading than 3½ oz. per square foot should ever be used; a lighter loading makes the machine extremely slow and susceptible to the slightest wind, apart from the fact that the elevation is difficult to adjust owing to the rush of power at the start. If the machine is adjusted for correct elevation when the screws are half unwound, and the full number of turns then applied, the machine will be over-elevated, and if it is adjusted to fly correctly with full turns, it will appear to be under-elevated when the initial burst of power has subsided. More heavily-loaded machines are not so difficult to adjust.



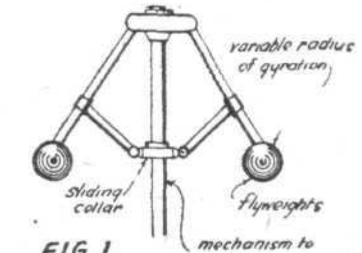


FIG. 1.

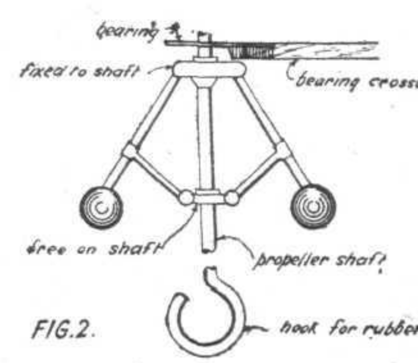


FIG. 2.

Governor for Rubber and Compressed Air

The great objection to rubber and compressed air is that the thrust or power commences to drop directly the model is released for flight. It has occurred to me that Watt's governor, as used on steam-engines and now adapted to many other mechanisms, including the gramophone, would make an excellent reducer either for the rubber motor or for compressed-air engines. The original governor design is shown in Fig. 1, and an adaptation for rubber motors is sketched in Fig. 2; it will be noticed that when the power is high the ball balance weights fly outward and increase the diameter of what is virtually a flywheel; and as the power decreases the balls revolve through a smaller radius, and hence tend to stabilise the revolutions—to keep them constant. The total weight of such an apparatus need not be more than 1 oz., but sufficient length of slide should be allowed so that the balls may fly to their correct radius in consonance with the power applied. The point I wish to make clear is that if too short a sliding motion is allowed the reducing effect will be lost, because centrifugal force will have a tendency to throw the balls farther than the stop will permit. A little trial and error with the length of travel of the sliding sleeve and the weight of the balls will soon reveal the most suitable arrangement. Such an adaptation of Watt's governor would be extremely useful on model hydroplanes, where a large quantity of elastic is required in order to overcome the extra resistance of the floats. It also eliminates the necessity for gearing down.

With regard to compressed air, such an arrangement could be made to work behind the screw with stationary engines, or be attached to the engine itself with rotary ones. It could, moreover, be made to actually operate a reducing valve, by interposing a spring between the stop and the sliding collar, so that the reducing valve remains closed whilst the machine is stationary. Many weird reducing valves have been advanced for use on compressed-air engines, but here, I think, lies the solution to the difficulty.

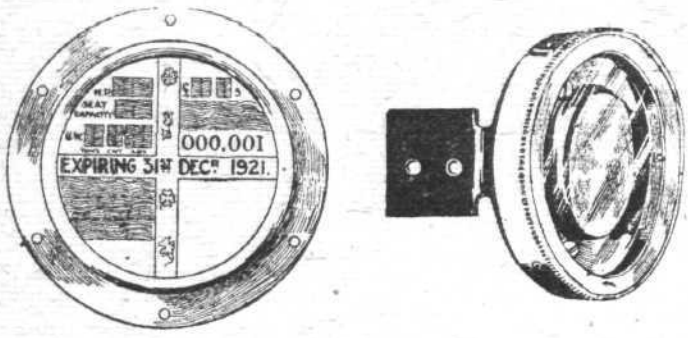
The Need for Research

I have many times in these columns impressed the need for more research and more care in the tabulation of results, and perhaps the fact that model aeroplaning does not attain to the popularity accorded to fretwork (!) by the younger fry is due to the easily satisfied and ephemeral desire to watch a model fly. This desire does not last. There is too much cultivation of the build-models-to-fly-them element by the clubs. How much more satisfying it is to know the why and wherefore, to know just *why* that extra strand was required, or why that other pair of screws or wings is more efficient. The hobbies of model locomotive and model yacht building are almost an exact science: their protagonists have carefully investigated every possible phase that lent itself to research. Only a small band indeed tackle model aeroplaning from this standpoint. It is just as interesting to conduct whirling arm experiments, or find the lift drag ratio of a given wing section, as it is to watch a model flying over the tree-tops.

Again, even with the flying of models, the same *laissez-faire* spirit exists. It is only in occasional cases that one sees carefully recorded the performances of each model built, with results of alterations, etc., noted. Such records make interesting reading when in retrospective mood. It is hoped that the K.M.A.A. will not disregard this matter, which is of cardinal importance to the whole movement.

SIDE-WINDS

In connection with the new licences, which have to be carried on the car, one point which should be borne in mind by those who are purchasing the necessary holder is that as this will be a permanent fitting on the car it is advisable to have one that is well made. We illustrate two types of which immediate delivery can be given by Messrs. S. Smith and Sons (M.A.), Ltd., of 179-185, Great Portland Street, London, W. 1. Needless to say, in common with all Smith's accessories, this licence-holder is finished in the very best style, and,



what is more, is sold in the one style at a very moderate price, viz., 5s. in brass and 6s. in nickel. This model is intended to screw drectly on to the wind-screen or any other prominent near-side portion of the car.

- - -

The second style illustrated is the "de luxe" model, which is designed to match the speedometers and bezel-wind clocks made by the same firm. It is secured by means of a bracket as shown, which can be disposed at will at the bottom, top or either side of the holder proper, thus permitting the holder to be fitted in any desired position. It can also be supplied with a clip fitting, for use on motor-cycles, securing it to the frame or handle-bar. Of this "de luxe" pattern the prices are 7s. 6d. and 8s. 6d. respectively for brass and nickel finishes. Made throughout in the Cricklewood works of the firm, these holders are already being supplied to Scotland Yard for all cars, cycles and vans used by that department.

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It is encouraging to hear that efforts are being made in Australia to keep aviation flying. Messrs. Simpson and Tregilles write from Perth, W. Australia, that they are building two small two-seaters, and they have ordered an A.W. FK 8 from the Disposal Co. They have secured a long lease of the best 50 acres of land suitable for an aerodrome, and are putting up a large hangar. Good luck to them.

- - -

Word also comes from Pratt Brothers that they have established the Geelong Air Service in Victoria, Australia, and are seeking agencies for aeroplanes, seaplanes and parts, aero engines, timbers, fabrics, dope, small parts, etc., as well as wood-working machinery and aviation instruments and accessories. Their aerodrome is at Geelong, Victoria, Australia.

PUBLICATIONS RECEIVED

Motor Cycling and Lubrication. C. C. Wakefield and Co., Ltd., Wakefield House, Cheapside, E.C.2.

The Manufacture and Use of Plywood and Glue. By B. C. Boulton, B.Sc., London. Sir Isaac Pitman and Sons, Ltd. Price 7s. 6d. net.

The Service Handbook. Compiled by Capt. H. H. C. Baird, D.S.O. London: Office of *The Service Man*, 115, Fleet Street, E.C. Price 2s. 6d.

Gray Wings. Words and Music of a Song by Ensign George M. Murray and Lieut. Rushmore Wood. Published by Bowles, 353, Adams Street, Brooklyn, N.Y., U.S.A.

The National Physical Laboratory Collected Researches. Vol. XIV, 1920. London: H.M. Stationery Office. Price 25s. net.

Utilisation Scientifique Controle des Bois dans l'Aviation et l'Industrie. By E. Pitois. Paris: Librairie Delagrave, 15, rue Soufflot.

The History of Sixty Squadron, R.A.F. By Group-Capt. A. J. L. Scott. London: William Heinemann. Price 15s. net.

Catalogues

Rover Motor Cycles, 1921. The New Rover Cycle Co., Ltd., Coventry.

Rover Bicycles, 1921. The New Rover Cycle Co., Ltd., Coventry.

COMPANY MATTERS

C. A. Vandervell and Co.

The report for the year ended March 31, 1920, states that notwithstanding the setback in the motor-trade during the autumn of 1919 (owing to moulders' strike) the turnover for year under review was substantially increased. Extensions to works are now nearing completion, which will practically double its capacity. The directors state they have secured certain patent rights, which should have considerable bearing on future prosperity of company.

The profit, less provision for income tax, £20,000, amounts to £106,206, and £139,293, is brought forward. The dividend on preferred ordinary shares of 10 per cent. absorbs £30,000, and directors recommend placing to reserve £75,000 and carrying forward £140,499.

Owing to the general industrial position, directors have decided to retain all available funds, in particular to make provision towards cost of extensions mentioned above, and they therefore do not propose to recommend the distribution of any further dividend this year by way of participation.

Sopwith Aviation Company

On the petition of Messrs. H. M. Hobson, Ltd., Mr. Justice P. O. Lawrence, in the Chancery Division, on December 21, sanctioned the appointment of two liquidators and a committee of inspection in the affairs of the Sopwith Aviation and Engineering Co., Ltd. It was stated that a resolution in favour of two liquidators was unanimously passed at a meeting of 147 creditors, representing £56,000.

AERONAUTICAL PATENT SPECIFICATIONS

Abbreviations: cyl. = cylinder; I.C. = internal combustion; m. = motors

The numbers in brackets are those under which the Specifications will be printed and abridged, etc.

APPLIED FOR IN 1918

Published December 30, 1920

3,223. G. Castagneris. Wing-arrangements for flying-machines carrying great loads. (154,633.)

APPLIED FOR IN 1919

Published December 30, 1920

18,833. Vickers, Ltd., R. K. Pierson and T. S. Duncan. Aircraft landing gear. (154,657.)

27,242. Boulton and Paul and J. D. North. Multiple-engine aeroplanes. (154,776.)

APPLIED FOR IN 1920

Published December 30, 1920

5,995. Soc. Anon. Nieuport-Macchi. I.C. engines. (146,924.)

If you require anything pertaining to aviation, study "Flight's" Buyers' Guide and Trade Directory, which appears in our advertisement pages each week (see pages xv and xvi).

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